GLENRIDGE MIDDLE SCHOOL

LANDOVER HILLS, MARYLAND

PRINCE GEORGE'S COUNTY PUBLIC SCHOOLS

PROJECT MANUAL
Volume 2 of 2
Divisions 21 through 33

FOR

BID SET
June 26, 2020

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SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

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

2.2 SLEEVE-SEAL SYSTEMS

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

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

2.3 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

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 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves
    b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system

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

    b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system

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

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system

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

    b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system

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

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves
    b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves

5. Interior Partitions:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 21 05 23 - GENERAL-DUTY VALVES FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Iron butterfly valves with indicators.
2. Check valves.
3. Iron OS&Y gate valves.
4. Trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.

2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

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

I. Valve Actuator Types:

1. Handwheel: For other than quarter-turn trim and drain valves.
2. Handlever: For quarter-turn trim and drain valves NPS 2 (DN 50) and smaller.

J. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

2.2 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Crane Co.; Crane Valve Group; Jenkins Valves.
2. Crane Co.; Crane Valve Group; Stockham Division.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO INC.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM.
7. Actuator: Worm gear or traveling nut.

8. Body Design: Lug.
9. Supervisory Switch: Internal or external

2.3 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
9. Or approved equal

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: bronze.
5. Clapper: Bronze, ductile iron, or stainless stee, with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.4 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc
9. Or approved equal

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves.

2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. End Connections: Flanged.
9. Supervisory Switch: External

2.5 TRIM AND DRAIN VALVES

A. Angle Valves:
1. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 211200 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
2. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

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

G. Install valve tags. Comply with requirements for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

END OF SECTION

SECTION 21 11 19 - FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exposed-type fire-department connections.
2. Flush-type fire-department connections.

1.2 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 each fire-department connection.

PART 2 - PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Exposed, projecting, for wall mounting.

C. Pressure Rating: 175 psig (1200 kPa) minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Round, brass, wall type.

H. Outlet: Back, with pipe threads.

I. Number of Inlets: Two.

J. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."

K. Finish: Polished chrome plated.

L. Outlet Size: NPS 4 (DN 100).

2.2 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Flush, for wall mounting.

C. Pressure Rating: 175 psig (1200 kPa) minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers. Provide FDC locks on inlets. Locks shall be made from brass or stainless steel.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Rectangular, brass, wall type.

H. Outlet: With pipe threads.

I. Body Style: Horizontal.

J. Number of Inlets: Two.

K. Outlet Location: Back.

L. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."

M. Finish: Polished chrome plated.

N. Outlet Size: NPS 4 (DN 100).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wall-type fire-department connections.

B. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION

SECTION 21 12 00 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Pressure gages.

B. Related Requirements:

1. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-suppression standpipes.

1. Include plans, elevations, sections, and attachment details.

C. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Fire-hydrant flow test report.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

A. Wet-Type, Standpipe System: Includes NPS 1-1/2 hose stations. water-supply valve with pressure maintained and is capable of supplying water demand.

2.2 PERFORMANCE REQUIREMENTS

A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Fire-suppression standpipe design shall be approved by Prince George's County Fire Marshal's Office.

2.3 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A 53/A 53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.

B. Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.

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

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

E. Cast-Iron Flanges: ASME B16.1, Class 125.

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

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

H. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175 psig minimum.
2. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.4 PIPING JOINING MATERIALS

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

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

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

2.5 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: Zero to 250 psig minimum.

D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 WATER-SUPPLY CONNECTIONS

A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

3.3 PIPING INSTALLATION

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

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

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

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

D. Install drain valves on standpipes. Extend drain piping to outside of building.

E. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

F. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

G. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

H. Fill standpipe system piping with water.

I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.

3.6 HOSE-CONNECTION INSTALLATION

A. Install NPS 1-1/2 hose-connection valves with flow-restricting device.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
4. Coordinate with fire-alarm tests. Operate as required.
5. Coordinate with fire-pump tests. Operate as required.
6. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.10 PIPING SCHEDULE

A. Wet-type fire-suppression standpipe piping, NPS 4 and smaller, shall be one of the following:

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

B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 5 to NPS 8 shall be one of the following:

1. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

END OF SECTION

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Manual control stations.
6. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: For wet-pipe sprinkler systems.

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

D. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

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

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by Prince George's County Fire Marshal's Office, including hydraulic calculations.

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

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

1. NFPA 13.

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

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design Standpipe and wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: September 19, 2018
b. Time: 11:48 a.m.
c. Performed by: WSSC.
d. Location of Residual/Static Hydrant R: Greenland St. and Crofton PL.
e. Location of Flow Fire Hydrant F: Greenland St. and Wiley St.
f. Static Pressure at Residual Fire Hydrant R: 41 psig
g. Measured Flow at Flow Fire Hydrant F: 2430 gpm
h. Residual Pressure at Residual Fire Hydrant R: 30 psig

2. The contractor shall provide an updated flow test at the start of construction. If this flow test differs from the test data above, it shall be used as the basis of design for the hydraulically designed sprinkler system.

3. The Sprinkler system design and installation shall be approved by the Prince George's County Fire Marshal's Office.

    a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    b. Sprinkler Occupancy Hazard Classifications:
        a) Building Service Areas: Ordinary Hazard, Group 1
        b) Electrical Equipment Rooms: Ordinary Hazard, Group 1
        c) General Storage Areas: Ordinary Hazard, Group 1
        d) Mechanical Equipment Rooms: Ordinary Hazard, Group 1
        e) Office and Public Areas: Light Hazard
        f) Classrooms: Light Hazard
        g) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

4. Minimum Density for Automatic-Sprinkler Piping Design:
    a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. Area.
    b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

5. Maximum Protection Area per Sprinkler:
    a. Office Spaces: 225 sq. ft.
    b. Storage Areas: 130 sq. ft.
    c. Mechanical Equipment Rooms: 130 sq. ft.
    d. Electrical Equipment Rooms: 130 sq. ft.
    e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method.

B. Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M.

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

D. Steel Couplings: ASTM A 865/A 865M, threaded.

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

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

G. Cast-Iron Flanges: ASME 16.1.

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

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or EPDM rubber gasket.

    a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

I. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers.
    a) Anvil International, Inc.
    b) Central Sprinkler Corp.
    c) Ductilic, Inc.
    d) JDH Pacific, Inc.
    e) National Fittings, Inc.
    f) Shurjoint Piping Products, Inc.
    g) Southwestern Pipe, Inc.
    h) Star Pipe Products; Star Fittings Div.
    i) Victaulic Co. of America.
    j) Ward Manufacturing.
    k) Or approved equal

2. Pressure Rating: 175- minimum.
3. Grooved-End Fittings ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

J. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

1. Manufacturers.
    a) Anvil International, Inc.
    b) Central Sprinkler Corp.
    c) Ductilic, Inc.
    d) JDH Pacific, Inc.
    e) National Fittings, Inc.
    f) Shurjoint Piping Products, Inc.
    g) Southwestern Pipe, Inc.
    h) Star Pipe Products; Star Fittings Div.
    i) Victaulic Co. of America.
    j) Ward Manufacturing.
    k) Or approved equal

2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Specialty Valves Pressure Rating: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:
1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

G. Automatic (Ball Drip) Drain Valves:
1. Manufacturers:
   a. AFAC Inc.
   b. Grinnell Fire Protection.
   c. Central Sprinkler Corp.
   d. Or approved equal
2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4
6. End Connections: Threaded.

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:
1. Manufacturers:
   a. Anvil International, Inc.
   b. Central Sprinkler Corp.
   c. Ductilic, Inc.
   d. JDH Pacific, Inc.
   e. National Fittings, Inc.
   f. Shurjoint Piping Products, Inc.
   g. Southwestern Pipe, Inc.
   h. Star Pipe Products; Star Fittings Div.
   i. Victaulic Co. of America.
   j. Ward Manufacturing.
   k. Or approved equal.
2. Standard: UL 213.
3. Pressure Rating: 175-psig
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
1. Manufacturers:
   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire-End and Croker Corp.
   c. Potter-Roemer; Fire-Protection Div.
   d. Or approved equal.
2. Standard: UL 199.
3. Pressure Rating: 175 psig
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers:
   a. AGF Manufacturing Co.
   b. Central Sprinkler Corp.
   c. G/J Innovations, Inc.
   d. Triple R Specialty of Ajax, Inc.
   e. Or approved equal
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Manufacturers:
   a. CECA, LLC.
   b. Merit.
   c. Central Sprinkler Corp.
   d. Or approved equal.
2. Standard: UL 1474.
3. Pressure Rating: 250-psig
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:
1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.

3. Pressure Rating: 175-psi minimum.
4. Size: Same as connected piping, for sprinkler.

2.5 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFAC Inc.
2. Central Sprinkler Corp.
3. Firematic Sprinkler Devices, Inc.
4. Globe Fire Sprinkler Corporation.
5. Grinnell Fire Protection.
6. Reliable Automatic Sprinkler Co., Inc.
7. Star Sprinkler Inc.
8. Venus Fire Protection, Ltd.
9. Victaulic Co. of America.
10. Viking Corp
11. Or approved equal

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199
3. Characteristics: All sprinkler types shall be Quick-response sprinklers. Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax lead and corrosion-resistant paint.

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

1. Ceiling Mounting: Chrome-plated steel.
2. Sidewall Mounting: Chrome-plated steel.

I. Sprinkler Guards:
1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 MANUAL CONTROL STATIONS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.

B. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.7 PRESSURE GAGES

A. Manufacturers:
1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Dresser Equipment Group; Instrument Div.
4. Or approved equal

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0- to 250- Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in other specification sections for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping

3.2 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.3 PIPING INSTALLATION

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

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

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

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

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

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

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

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

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

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

K. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

L. Fill sprinkler system piping with water.

M. Install sleeves for piping penetrations of walls, ceilings, and floors.

N. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

L. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

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

3.5 VALVE AND SPECIALTIES INSTALLATION

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

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.6 SPRINKLER INSTALLATION

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

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

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

3.7 IDENTIFICATION

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

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

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

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.

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

C. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints.

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

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

1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 8 shall be one of the following:
1. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

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

1. Rooms without Ceilings: Upright sprinklers
2. Rooms with Suspended Ceilings: Pendent, or adjustable recessed pendent sprinklers, as required.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Pendent, Sidewall, or Upright dry sprinklers, as required
5. Special Applications: Extended-coverage, quick-response sprinklers where indicated.

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

1. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
2. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 21 31 13 - ELECTRIC-DRIVE CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. End-Suction Split-Case fire pumps
   2. Fire-pump accessories and specialties.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

1.3 SUBMITTALS

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

B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.

C. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.

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

D. Product Certificates: For each fire pump, from manufacturer.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and maintenance data.

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. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

A. Description: Factory-assembled and -tested fire-pump and driver unit.

B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.2 END-SUCTION, SPLIT-CASE FIRE PUMPS

A. Basis of Design Manufacturer: Subject to compliance with requirements, provide fire pump as scheduled on the drawing or approved equal by one of the following:

1. Aurora Pump, Inc.
2. Peerless Pump, Inc
3. Pentair Pump Group; Fairbanks Morse.
4. Reddy-Buffaloes Pump Company.
5. S.A. Armstrong Limited.

B. Pump Description

1. Standard: 4 inch suction x 4 inch discharge, Vertical Inline, UL listed and FM approved.
2. Casing: Bronze fitted cast iron with ASME B16.1 pipe-flange connections.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Carbon Steel AISI 1144 shaft with bronze sleeve.

    a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
    b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shaft vertically mounted, with motor above pump and pump on base.

7. Flow: As scheduled on the drawing.

C. Coupling: None or rigid.

D. Driver:

1. Standard: UL 1004A
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

E. Capacities and Characteristics: As scheduled on the drawing.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves: Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Discharge Cone: Closed or open type.

G. Provide Jockey Pump as scheduled on the drawing or approved equal.

H. Provide Fire Pump Controller ¾ inch relief valve Automatic Transfer Switch (ATS) and Jockey Pump Controller as recommended by the fire pump manufacturer (FIRETROL Jockey Pump controller), Coordinate with electrical design and specifications.

I. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.

5. Manifold:

a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
c. Escutcheon Plate: Brass or bronze; round.
d. Exposed Parts Finish: Polished, chrome plated.
e. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 GROUT

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

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

C. Design Mix: 4000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1. Verification of Performance: Rate fire pumps according to UL 448.

B. Fire pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

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

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in "Division 21 Section "Wet-Pipe Sprinkler Systems**."**

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

J. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.3 ALIGNMENT

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in Division 21 Section "Wet-Pipe Sprinkler Systems**."** Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section "Controllers for Fire-Pump Drivers."

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

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. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
2. Test according to NFPA 20 for acceptance and performance testing.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION

SECTION 21 39 00 - CONTROLLERS FOR FIRE-PUMP DRIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Limited-service controllers rated 600 V and less.
2. Controllers for pressure-maintenance pumps.
3. Remote alarm panels.

1.2 DEFINITIONS

A. ATS: Automatic transfer switch.

B. ECM: Electronic control module.

C. MCCB: Molded-case circuit breaker.

1.3 SUBMITTALS

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

B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.

1. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
2. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.

C. Qualification Data: For qualified testing agency.

D. Manufacturer's factory test reports of fully assembled and tested equipment.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and maintenance data.

H. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

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 standards of authorities having jurisdiction pertaining to materials and installation.

D. Comply with NFPA 20 and NFPA 70.

PART 2 - PRODUCTS

2.1 LIMITED-SERVICE CONTROLLERS

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

1. Aquarius Fluid Products, Inc.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Hubbell Incorporated; Hubbell Industrial Controls.
4. Joslyn Clark Corporation.
5. Metron, Inc.
6. Or Approved Equal.

B. General Requirements for Limited-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Listed by an NRTL for electric-motor driver for fire-pump service.
3. Combined automatic and nonautomatic operation.
4. Factory assembled, wired, and tested; continuous-duty rated.
5. Service Equipment Label: NRTL labeled for use as service equipment.

C. Method of Starting:

1. Pressure-switch actuated.
    a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
    b. System pressure recorder, electric ac driven, with spring backup.
    c. Programmable minimum-run-time relay to prevent short cycling.
    d. Programmable timer for weekly tests.
2. Across-the-line magnetic controller.
3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

F. Method of Isolation and Overcurrent Protection: Inverse-time, nonadjustable MCCB, with an externally mounted operating handle.

G. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

    a. Microprocessor-based logic controller, with multiline LCD digital readout.
    b. Membrane keypad.
    c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

    a. Controller power on.
    b. Motor running condition.
    c. Loss-of-line power.
    d. Line-power phase reversal.
    e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons.

H. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008. Rated at minimum 200 Amperes, 3-Pole at 480V.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
6. Local and Remote Alarm and Status Indications:

    a. Normal source available.
    b. Alternate source available.
    c. In normal position.
    d. In alternate position.
    e. Isolating means open.

7. Audible alarm, with silence push button.
8. Nonautomatic (manual, nonelectric) means of transfer.

9. Engine test push button.
10. Start generator output contacts.
11. Timer for weekly generator tests.

2.2 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

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

1. Aquarius Fluid Products, Inc.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Hubbell Incorporated; Hubbell Industrial Controls.
4. Joslyn Clark Corporation.
5. Metron, Inc.
6. Or Approved Equal.

B. General Requirements for Pressure-Maintenance-Pump Controllers:

1. Type: UL 508 factory assembled, wired, and tested, across-the-line; for combined automatic and manual operation.
2. Enclosure: UL 508 and NEMA 250, Type 2 for floor-mounting.
3. Factory assembled, wired, and tested.
4. Finish: Manufacturer's standard color paint.

C. Rate controller for scheduled horsepower and include the following:

1. Fusible disconnect switch.
2. Pressure switch.
3. Hand-off-auto selector switch.
4. Pilot light.
5. Running period timer.

2.3 REMOTE ALARM PANELS

A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.

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

1. Aquarius Fluid Products, Inc.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Hubbell Incorporated; Hubbell Industrial Controls.
4. Joslyn Clark Corporation.
5. Metron, Inc.
6. Or Approved Equal.

C. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.

D. Supervisory and Normal Control Voltage: 120-V ac source.

E. Audible and Visual Alarm and Status Indications:

1. Driver running.
2. Loss of phase.
3. Phase reversal.
4. Supervised power on.
5. Common trouble on the controller.

6. Controller connected to alternate power source.

F. Audible alarm, with silence push button.

2.4 ENCLOSURES

A. Fire-Pump Controllers, ATS, and Remote Alarm Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
1. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

D. Floor stands, 12 inches high, for floor-mounted controllers.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 CONTROLLER INSTALLATION

A. Install controllers within sight of their respective drivers.

B. Connect controllers to their dedicated pressure-sensing lines.

C. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Comply with NEMA ICS 15.

3.2 REMOTE ALARM PANEL INSTALLATION

A. Install panels on walls with tops not higher than 72 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For panels not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

3.3 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Conductors and Cables."

B. Comply with NECA 1.

3.4 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."

B. Install wiring between remote alarm panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."

C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 Section "Digital, Addressable Fire-Alarm System."

D. Bundle, train, and support wiring in enclosures.

E. Connect remote manual and automatic activation devices where applicable.

3.5 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 26 Section "Electrical Identification."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

    a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
    b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
    c. Test continuity of each circuit.

2. Verify and Test Each Electric-Driver Controller:

    a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Architect/Engineer and Construction Manager before starting the motor.
    b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Architect/Engineer, Construction Manager and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

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

E. Prepare test and inspection reports.

F. Perform startup service.

G. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controllers remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment.

END OF SECTION

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 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.

1.2 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 unless otherwise indicated.

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: Energy efficient, as defined in NEMA MG 1.

C. 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.

D. Rotor: Random-wound, squirrel cage.

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

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. 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.

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: Pre-lubricated, 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

SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber union connector packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Alignment guides and anchors.
4. Pipe loops and swing connections.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end-connections, and location for each expansion joint.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

A. Rubber Union Connector Expansion Joints

1. Material: Twin reinforced-rubber spheres.
2. Minimum Pressure Rating: 150 psig at 170 deg F (1035 kPa at 77 deg C**)**, unless otherwise indicated.
3. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

B. Flexible-Hose Packless Expansion Joints:

1. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
2. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
3. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.

    a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.

4. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install **one** guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than **four** pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

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

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

2.2 SLEEVE-SEAL SYSTEMS

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

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

2.3 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

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 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6 Galvanized-steel wall sleeves
   b. Piping NPS and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system

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

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system

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

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6 Cast-iron wall sleeves with sleeve-seal system

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

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system

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

4. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

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

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

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.2 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
1. Ernst Gage Co.
2. Marsh Bellofram.
3. NANMAC Corporation.
4. Palmer - Wahl Instruments Inc.
5. Tel-Tru Manufacturing Company.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
9. Or approved equal.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

E. Connector Type(s): Union joint, adjustable angle type, with unified-inch screw threads.

F. Connector Size: 1/2 inch with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Palmer - Wahl Instruments Inc.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.
   d. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
   e. Or approved equal.

2. Standard: ASME B40.200.
3. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass
8. Stem: Aluminum 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.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI
4. Material for Use with Steel Piping: CRES
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages

1. Acceptable Manufactures
   a. AMETEK, Inc.; U.S. Gauge Div.
   b. Ashcroft (Dresser Instrument).
   c. Miljoco Corporation.
   d. Palmer - Wahl Instruments Inc.
   e. H. O. Trerice.
   f. Weiss Instruments, Inc.
   g. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Solid-front, pressure relief type(s); cast aluminum or drawn steel 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: 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: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass
10. Ring: Metal
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle NPS 1/4 or NPS 1/2 (ASME B1.20.1 pipe threads.

2.6 WATER METERING

A. Meters capable of the following:

1. Recording daily water consumption.
2. Communicating data remotely.
3. Electronic data storage for five years.
4. Reports showing daily, monthly, and annual water consumption.
5. Alarming capability in accordance with Water User Efficiency Plan for Operation.
6. Provide interface with Building Management Control System for alarming and reporting of data.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Onicon FT-3100 Inline Electromagnetic Flow Meter, with flange connection ends, or approved equal.

C. Submeter the following:

1. As indicated on the plans and
2. Automatically controlled irrigation systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

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

H. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.

I. Install pressure gages 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.

J. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

K. Adjust faces of meters and gages to proper angle for best visibility.

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be:

1. Liquid-filled bimetallic-actuated type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be the following:

1. Liquid-filled Sealed, bimetallic-actuated type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:

1. Liquid-filled Sealed, bimetallic-actuated type.

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

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be the following:

1. Liquid-filled Sealed Open-front, pressure-relief Solid-front, pressure-relief type, mounted, metal case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:

1. Liquid-filled Sealed Solid-front, metal case.

C. Pressure gages at suction and discharge of each domestic water pump shall be the following:

1. Liquid-filled Sealed Solid-front, metal case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

END OF SECTION

SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze ball valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

   1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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 B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   3. ASME B16.18 for solder-joint connections.
   4. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for 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.

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

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

G. Valve Actuator Types:

   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4 .

H. Valves in Insulated Piping:

   1. Include 2-inch stem extensions.

2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES.

A. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

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

B. 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.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.3 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint, threaded ends, or press-connection.
2. Two-piece, bronze ball valves with full port and bronze trim.

END OF SECTION

SECTION 22 05 23.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron, single-flange butterfly valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS.

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B31.9 for building service piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

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

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

F. Valve Actuator Types:

1. Handlever: For valves NPS 6 and smaller.

G. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
1. Acceptable Manufactures

a. Bray
b. DeZurik
c. Keystone
d. Milwakee Valve
e. Nibco
f. Victaulic
g. Walworth

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 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

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

B. 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.

3.2 ADJUSTING

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

3.3 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze disc.

END OF SECTION

SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze swing check valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for 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.

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

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

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

2.2 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1.
a. Combination Pump and Valve
b. Mueller
c. Nibco
d. Victaulic
2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

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

B. 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 swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

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

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Pump-Discharge Check Valves:

a. NPS 4 and Smaller: Bronze swing check valves with bronze disc.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:
   1. .
   2. For Steel Piping, NPS 2 and Smaller: Threaded.
   3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 125, bronze disc with threaded end connections.

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

   1. Bronze swing check valves, Class 125, bronze disc with threaded or flanged end connections.

END OF SECTION

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 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.

1.3 ACTION SUBMITTALS

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

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

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Stainless-Steel Pipe Hangers and Supports:

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

2.2 PIPE POSITIONING SYSTEMS

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

2.3 EQUIPMENT SUPPORTS

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

2.4 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

C. Fastener System Installation:

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

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

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

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

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

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

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

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

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

L. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

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

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

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

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

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

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6 18 inches long and 0.06 inch thick.

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

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

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

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

3.4 ADJUSTING

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

3.5 PAINTING

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24 , requiring up to 4 inches of insulation.

G. 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.

H. 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.

I. 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.

J. 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.

K. 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.

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

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

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

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 SUBMITTAL

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. 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.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

2.2 WARNING SIGNS AND LABELS

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

B. Letter Color: Red

C. Background Color: White

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

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

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

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

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

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, 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.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:
   1. Domestic Hot and Recirculating Filtered Hot Water Piping:
      a. Background Color: Green
      b. Letter Color: White.
   2. Domestic Filtered Cold Water Piping:
      a. Background Color: Green.
      b. Letter Color: White
   3. Domestic Un-Filtered Cold Water Piping:
      a. Background Color: Green.
      b. Letter Color: White
   4. Sanitary Waste, Storm, and Vent Piping:
      a. Background Color: Brown
      b. Letter Color: White.
   5. Fire Protection Standpipe and Sprinkler Piping:
      a. Background Color: Dark Red
      b. Letter Color: White
   6. Condensate Drain Piping:
      a. Background Color: Green
      b. Letter Color: White
   7. Natural Gas Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.

C. Natural Gas piping located outdoors, exposed and on roof, shall be primed and painted in accordance with architectural specifications and labeled.

END OF SECTION

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold and hot-water piping.
2. Domestic recirculating hot-water piping.
3. Sanitary waste piping exposed to freezing conditions.
4. Storm-water piping exposed to freezing conditions.
5. Roof drains and rainwater leaders.
6. Supplies and drains for handicap-accessible lavatories and sinks
7. Condensate drain.

1.2 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

2. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that product complies 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," including 2004 Addenda.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

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

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

G. Mineral-Fiber, Preformed Pipe Insulation:
1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

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

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.
      e. Or approved equal.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.
      f. Or approved equal.

2.4 SEALANTS

A. Joint Sealants for Cellular-Glass Products:
   1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
      f. Vimasco Corporation; 750.
      g. Or approved equal
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F.
   5. Color: White or gray.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated..

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
   e. Or approved equal.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by Architect.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209 Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
   d. Or approved equal.
2. Factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper
5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket.
   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange and union covers.
   e. End caps.
   f. Beveled collars.
   g. Valve covers.
   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
      e. Or approved equal.
   2. Width: 3 inches .
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
      e. Or approved equal.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
   8. Width: 3 inches .
   9. Thickness: 6.5 mils.
   10. Adhesion: 90 ounces force/inch in width.
   11. Elongation: 2 percent.
   12. Tensile Strength: 40 lbf/inch in width.
   13. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      b. Compac Corp.; 120.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
      d. Venture Tape; 3520 CW.
      e. Or approved equal
   2. Width: 2 inches
   3. Thickness: 3.7 mils
   4. Adhesion: 100 ounces force/inch in width.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Aluminum Bands: ASTM B 209 Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products; Bands.
      b. PABCO Metals Corporation; Bands.
      c. RPR Products, Inc.; Bands.
      d. Or approved equal.

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

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, :
   1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures,
   1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

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

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

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

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

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

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

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

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

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

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

3.3 PENETRATIONS

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

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

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

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

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

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

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

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

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

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

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

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

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

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.6 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), 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.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

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

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

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

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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, Hot and Recirculated Hot Water (Including Filtered water): Insulation shall be:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I:1 inch thick

B. Domestic, cold Water (Including Filtered water) : Insulation shall be Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Stormwater and Overflow: Insulation shall be
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies: Insulation shall be:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:

1. Flexible Elastomeric: 1/2 inch thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I 1/2 inch thick.

F. Air-Conditioning condensate drain: Insulation shall be one of the following:
1. Flexible Elastomeric:1/2 inch thick.
2. Or Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping: Insulation shall be one of the following:
1. Flexible Elastomeric: 2 inches thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
1. None.

D. Piping, Exposed:
1. Aluminum, Smooth 0.016 inch thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed: None

D. Piping, Exposed:
1. Painted Aluminum, Smooth Corrugated 0.016 inch thick.

3.15 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes requirements for commissioning plumbing systems, assemblies, equipment, and components.

1. Commissioning is a third-party quality assurance process. It does not take the place of or duplicate the Contractor's quality control services required per Division 01 Section "Quality Requirements" or testing, adjusting, and balancing and other quality control testing or inspections required in individual Sections and normally the responsibility of the Contractor.

B. The following plumbing systems, assemblies, equipment, and components are to be commissioned on this Project:

Plumbing	CxP Submittal Review	Construction Checklist	Functional Test Sampling
22 11 23.21 Domestic Water Pumps			100%
22 11 19 Domestic Hot Water Mixing Valves			20%
22 14 29 Sump Pumps	Yes	Yes	100%
22 34 00 Fuel-Fired Domestic Water Heaters	Yes	Yes	100%

C. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for definitions of terms used in this Section, and for commissioning requirements applicable to all systems, including Plumbing.

1.2 INFORMATIONAL SUBMITTALS

A. Contractor Submittals and Shop Drawings: Concurrent with AE review, the Contractor will send submittals relating to systems to be commissioned to the CxP for review of compliance with the Contract Documents. Comments will be returned directly to the AE with a copy to the Owner for coordination of a final submittal review response from the AE to the Contractor. This includes all Division 22 submittals for systems referenced in 1.1 above.

B. Commissioning Documentation: Submit the following information to the CxP:

1. Schedule: Schedule for completing construction checklists, pre-functional and start-up for plumbing systems, assemblies, equipment and components to be commissioned.
2. Test Equipment, Instrumentation, and Tools: Submit list of test equipment, instrumentation, and tools required to perform functional performance testing. Identify

proprietary test equipment, instrumentation, and tools. Include calibration certificates for test equipment and instrumentation.

3. Checklists: Completed construction checklists, pre-functional checklists, point-to-point checklists and start-up forms for each piece of equipment or component.
4. Certificate of Readiness: Using FPT Certificate of Readiness form provided in Division 01 "General Commissioning Requirements," certify that plumbing systems, subsystems, equipment, components, and associated controls are ready for testing.
5. TAB Reports: Submit initial draft version as soon as available and follow with final version when complete.
6. Documentation of corrective actions for logged deficiencies.

1.3 CLOSEOUT SUBMITTALS

A. Commissioning issues reports showing resolution of issues.

1. Include correspondence or other documents related to resolution of issues.
2. List unresolved issues. Provide written explanation for why each item on the list remains unresolved. Indicate reason, if any, are exempt from the requirements for Construction Phase Commissioning Completion.

B. Training verification forms.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. General: Provide test equipment, instrumentation, and tools necessary to perform function performance testing. Use test equipment and instrumentation that has been calibrated, certified, and properly maintained.

1. Test equipment and instrumentation required to perform the commissioning shall remain the property of Contractor unless otherwise indicated.
2. Proprietary test equipment, instrumentation, and tools shall become the property of Architect at Substantial Completion.

a. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate or perform work on its equipment.

PART 3 - EXECUTION

3.1 COMMISSIONING PROVIDER (CxP) RESPONSIBILITIES

A. Meetings: Attend and lead commissioning team meetings.

B. Checklists: The CxP shall develop and provide Project-specific construction checklists.

C. TAB Verification: The CxP shall verify testing, adjusting, and balancing of Work is complete.

D. FPT Procedures: The CxP shall develop and provide functional performance test procedures for plumbing systems, assemblies, equipment and components, including to verify operation and integration of new components in existing systems.

E. FPT Testing: The CxP shall witness functional performance testing, and record test results.

F. Commissioning Record: The CxP shall author a commissioning summary report and verify functional performance test data and certificates are included in the commissioning record.

3.2 CONTRACTOR RESPONSIBILITIES

A. Meetings: Attend and participate in commissioning team meetings.

B. FPT Testing: Perform functional performance testing for systems, assemblies, equipment, and components indicated to be commissioned[, including seasonal testing].

C. Documentation: Provide information requested by the CxP.

D. Training: Participate in training for plumbing systems, assemblies, equipment and components.

E. Near-End-of-Warranty Walkthrough: Participate in the Near End-of-Warranty review meeting and walkthrough.

3.3 FUNCTIONAL PERFORMANCE TESTING (FPT) PREPARATION

A. Start-up: Certify that plumbing systems, subsystems and equipment have been installed, calibrated and started and are operating according to the Contract Documents.

B. Testing, Adjusting, and Balancing: Perform testing, adjusting, and balancing of plumbing systems as indicated in individual Sections.

1. Provide technicians, instrumentation and tools to verify testing, adjusting, and balancing of plumbing systems.
2. Conduct leak testing and submit reports to CxP.
3. Certify that testing, adjusting and balancing procedures have been completed per the Contract Documents and that balancing reports have been submitted.

C. Participation: Coordinate schedule to ensure that all required members of the Cx team as indicated in functional performance testing (FPT) procedures are available to participate in FPT.

3.4 GENERAL FPT REQUIREMENTS

A. General: Test all normal and emergency modes of operations including alarms.

1. To greatest extent possible, use design conditions for test parameters, unless otherwise directed by Architect and CxP.
2. Simulated conditions may be imposed to initially test systems; however this does not relieve the Contractor of his duty to perform deferred testing. Alter set points and sensor values when simulating conditions is not practical.

B. Re-Testing:

1. If tests indicate that system, assembly, equipment, or component does not meet acceptance criteria indicated, document the deficiency and report it to the Architect. Upon resolution of deficiencies, re-test using same original parameters unless otherwise directed by Architect and CxP. Notify Architect and CxP a minimum of [three] days before re-test date of rescheduled tests.
2. Deficiencies which prevent the verification of system performance may be uncovered during tests. In cases where the issue cannot be resolved within a reasonable amount of time, document the deficiency and report it to the Architect. Upon resolution of deficiencies, re-test using same original parameters unless otherwise directed by Architect and CxP. Notify Architect and CxP a minimum of three days before re-test date of rescheduled tests.

3.5 PLUMBING FPT PROCEDURES

A. Domestic Hot Water Heater (Storage-Type):

1. Procedures:

   a. Begin with water heater in standby.
   b. Initiate a call for heat by partially draining the storage tank or raising the hot water temperature setpoint.
   c. Verify water heater shuts off when temperature sensor is satisfied.
   d. Record typical domestic hot water loop delta temperature (supply temp. minus return temp.).
   e. Test the temperature and pressure relief valve.
   f. Confirm the presence of a condensate trap or neutralizer.
   g. Inspect for combustion hazards around the water heater (combustion type only).

2. Acceptance Criteria:

3.6 NEAR END-OF-WARRANTY REVIEW

A. General: Participate in the Near End-of-Warranty review and walkthrough conducted by CxP.

1. The review will cover current building operation with input from the operation and facility staff. Outstanding issues related to the construction, particularly those related to the OPR and warranty related deficiencies will be addressed. Operational problems and concerns from the facility staff and occupants will be reviewed for compliance with design intent.
2. The CxP, in consultation with the Architect/Engineer (AE), will provide recommendations for improvements and corrective measures to the Architect and the Contractor for action.

B. Corrective Action: Where deficiencies and problems result from work not in compliance with the Contract Documents or where corrective actions are covered under warranty, provide the corrective action at no additional cost to Architect.

END OF SECTION 22 08 00

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.2 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

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

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

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

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

E. Copper Unions:

1. MSS SP-123.

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

F. Copper Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Elkhart Products Corporation; Industrial Division
   b. NIBCO INC
   c. Viega; Plumbing and Heating Systems.

2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

G. Copper Push-on-Joint Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. NVent LLC.
   b. Or approved equal.

2. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Flanges: ASME B16.1, Class 125, cast iron.

2.4 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

2.5 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.

F. Solvent Cements for Joining CPVC Piping: ASTM F 493.

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

2.6 TRANSITION FITTINGS

A. General Requirements:

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

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

C. Plastic-to-Metal Transition Fittings:
1. Description:

a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

D. Plastic-to-Metal Transition Unions:
1. Description:

a. CPVC four-part union.
b. Brass or stainless-steel threaded end.

c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

2.7 DIELECTRIC FITTINGS

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

B. Dielectric Unions:
1. Standard: ASSE 1079.
2. Pressure Rating: minimum at 180 deg F 150 psig
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: minimum at 180 deg F 150 psig
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction

loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

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

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

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

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

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level with 0.25 percent slope downward toward drain without pitch and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

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

J. 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.

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

L. Install piping to permit valve servicing.

M. 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.

N. Install piping free of sags and bends.

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

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

Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

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

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

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

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

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

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

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

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

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

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

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

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flanges flange.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

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 1-1/4 and Smaller: 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 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 4: 48 inches with 1/2-inch rod.

I. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. 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.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING AND BALANCING

A. Perform the following adjustments and balancing 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 the required flow rate.

    a. Adjust calibrated balancing valves to flows indicated/required for system balancing.

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.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab and Incoming building-service water piping up to the main backflow preventer, NPS 3 to NPS 8 shall be the following:
   1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:

   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); and brazed joints.

F. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); and brazed joints or
   2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be the following:

   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast or wrought copper solder-joint fittings; and brazed joints.

END OF SECTION

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water-hammer arresters.
11. Trap-seal primer valves.
12. Freeze-less Roof Hydrant
13. Washer Out-let box

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Cash Acme.
    b. Conbraco Industries, Inc.

c. Honeywell Water Controls.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.
f. Or approved equal:

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig
4. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3 .

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Bell and Gossett "Circuit Setter"plus
b. Or approved equ
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES.

A. Water-Temperature Limiting Devices
1. Standard: ASSE 1070.
2. Pressure Rating: 125 psig.
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded or union inlets and outlet.
6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Valve Finish: Chrome plated or Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves
1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Type: Exposed-mounted Cabinet-type, thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

7. Valve Finish: Rough bronze.
8. Piping Finish: Copper.

2.8 HOSE BIBBS

A. Hose Bibbs

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle
13. Operation for Finished Rooms: Wheel handle
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants

1. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze
11. Operating Keys(s): One with each wall hydrant.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. Or approved equal
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. PPP Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Watts Industries, Inc.; Water Products Div.
   f. Or approved equal
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. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device

1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
2. Size: NPS 1-1/4 minimum.
3. Material: Chrome-plated, cast brass.

2.13 TRAP-SEAL PRIMER SYSTEM

A. Factory-fabricated, automatic-operation assembly for wall mounting with the following:
1. Piping: 3/4-inch NPS, ASTM B 88, Type L; copper, water tubing inlet and manifold with number of 1/2-inch NPS outlets as indicated.
2. Cabinet: Steel box with stainless-steel cover.
3. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V, ac power.
4. Water Hammer Arrester: ASSE 1010.
5. Vacuum Breaker: ASSE 1001.

2.14 FREEZE-LESS ROOF HYDRANT

A. Nonfreeze Roof Hydrants (RH-1):
1. Manufacturers: Subject to compliance with requirements, provide Woodford freezeless Roof Hydrant Model SRH-MS or approved equal by one of the following:
a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group; Light Commercial Operation.
2. Description: The Roof Hydrant shall be backflow protected with an ASSE 1057 double check backflow preventer that is field testable. The Roof Hydrant shall have a built-in vent that provides self-draining and shall require no drain line. Provide one-piece variable flow plunger, and ¾" hose connection.
3. Pressure Rating: 125 psig.
4. Operation: Leaver handle
5. Mounting: Provide all necessary mounting hardware for proper installation on a commercial roof.
6. Inlet: NPS 3/4 or NPS 1".

2.15 WASHER OUTLET BOX, WB-1.

1. Basis of Design: Subject to compliance with requirements, provide Acorn Model 8186 or approved equal by one of the following:
a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group; Light Commercial Operation.
2. Description: Recessed supply and waste hose box fabricated from 18 gage, type 304 stainless steel with satin finish. Provide ¾" hose connection for hot and cold water. Valves shall include integral vacuum breaker and be cartridge-operated type with vandal-resistant lockshield and screwdriver operated stop. Waste fitting shall be cast bronze with

with rough chrome finish and securely fixed to the box. Waste pipe shall accommodate a 2" diameter drain hose.

3. Pressure Rating: 125 psig.

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 water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. 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.

E. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.

F. Set non-freeze, nondraining-type post hydrants in concrete or pavement.

G. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

H. Install water-hammer arresters in water piping according to PDI-WH 201.

I. 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.

J. 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.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each reduced-pressure-principle backflow preventer backflow preventer 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.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 22 11 23.13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duplex, Variable-speed booster pumps.

1.2 PERFORMANCE REQUIREMENTS

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.

C. Sequence of operations

D. Power and control wiring diagrams

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. NSF/ANSI 61 for potable drinking water and NSF-61 Annex G for low lead content

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."

E. Product Data for each type of pump: Certification that pump material comply with NSF 61 Annex G and NSF 372.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic water booster pumps that fail in materials or workmanship within specified warranty period.

B. Warranty Periods: From date of Substantial Completion- Three years

PART 2 - PRODUCTS

2.1 DUPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Bell & Gosset Model 4SH2K5C4 as indicated on Drawing or comparable product by one of the following:
1. Armstrong pumps
2. Weil

B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

C. Pumps:

1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump.
2. Casing: Radially split; stainless steel.
3. Impeller: Stainless steel; statically and dynamically balanced and keyed to shaft.
4. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve and deflector.
5. Seal: Mechanical.
6. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.
7. Coupling: Flexible, with metal guard.

D. Motors: Variable speed, with pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

E. Piping: Copper tube and copper fittings headers and copper tube and copper fittings between headers and pump.

F. Valves:

1. Shutoff Valves NPS 2 (DN 50) and smaller: two-piece, full-port ball valve, in each pump's suction and discharge piping.
2. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
3. Check Valves NPS 2 (DN 50) and smaller: Silent or swing type in each pump's discharge piping.
4. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.
5. Control Valves: Combination adjustable, automatic, pilot-operated or direct-acting, pressure-reducing-and-check type in each pump's discharge piping.

6. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

G. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

H. 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.

1. Control Logic: Solid-state system with transducers, programmable microprocessor, and other devices in the controller.
2. Motor Controller: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with under-voltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.

    a. Control Voltage: 24 or 120-V ac, with integral control-power transformer.

3. Enclosure: TEFC.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

    a. Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation based on run-time, water demand, and user defined schedule.

6. Pump Operation and Sequencing: Current- or pressure- sensing method.

    a. Time Delay: Controls pump on-off operation; adjustable from 1 to 200 seconds.

7. Instrumentation: Suction and discharge pressure gages.
8. Lights: Running light for each pump.
9. Alarm Signal Device: Sounds alarm when backup pumps are operating.

    a. Time Delay: Controls alarm operation; adjustable from 1 to 200 seconds, with manual reset.

10. Thermal-bleed cutoff.
11. Low-suction-pressure cutout.
12. High-suction-pressure cutout.
13. Low-discharge-pressure cutout.
14. High-discharge-pressure cutout.
15. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet building automation system. Building automation systems are specified in Section 230900 "Instrumentation and Control for HVAC." Include the following:

    a. On-off status of each pump.
    b. Alarm status.

I. Base: Structural steel.

J. Capacities and Characteristics:

1. Minimum Pressure Rating: 150 psig .
2. Booster-Pump Capacity: As scheduled on the drawing.
3. Minimum Inlet Pressure:35 psig.
4. Discharge Pressure:75 psig.
5. Header Size: 4 NPS.
6. Each of Two Pumps:

    a. Capacity: As scheduled on the drawing.
    b. Total Dynamic Head: As scheduled on the drawing.
    c. Speed: 3600 rpm.
    d. Electrical Characteristics: As scheduled on the drawing

7. Booster-Pump Electrical Characteristics: As scheduled on the drawing

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 INSTALLATION

A. Equipment Mounting:

1. Install booster pumps on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

C. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "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 or valves same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," 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 221116 "Domestic Water Piping."
2. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge headers. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
3. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
4. Install piping adjacent to booster pumps to allow service and maintenance.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. 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.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 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.

3.6 DEMONSTRATION

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

3.7 COMMISSIONING

A. Provide support for commissioning activities and functional performance testing as outlined in specification section 019113 "General Commissioning Requirements"

END OF SECTION

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic water pumps that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion. Three years.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following manufacturers:

1. Armstrong Pumps
2. Bell & Gossett
3. Patterson Pump

B. Description: Factory-assembled and tested, in-line, Cartridge Design, single-stage, centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Capacities and Characteristics:

1. Capacity: As scheduled on the drawing.
2. Total Dynamic Head: As scheduled on the drawing.
3. Inlet and Outlet Size: As scheduled on the drawing.
4. Pump Control: Thermostatic.
5. Pump Speed: As scheduled on the drawing.
6. Motor Horsepower: As scheduled on the drawing.
7. Electrical Characteristics:

    a. Volts: 120V.
    b. Phases: Single phase.
    c. Hertz: 60 Hz.

D. Pump Construction:

1. Casing:

    a. Cast iron or bronze body, and flanged piping connections.
    b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
    c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Cast Iron or 304Stainless steel, hydraulically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Alloy steel shaft with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring and ceramic seal.
6. Bearings: permanently lubricated ball type.
7. Minimum Working Pressure: 175 psig (1200 kPa).
8. Continuous Operating Temperature: 225 deg F (107 deg C).

E. Motor: Single speed, with sleeve bearings or grease-lubricated ball bearings; mounted to pump casing.

2.3 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.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F (18 to 93 deg C).
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V ac.
7. Settings: Start pump at 105 deg F (41 deg C) and stop pump at 120 deg F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

D. Install thermostats in hot-water return piping.

E. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

F. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.
b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 FIELD QUALITY CONTROL

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

B. Pre-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 motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

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

3.6 COMMISSIONING

A. Provide support for commissioning activities and functional performance testing as outlined in specification section 019113 "General Commissioning Requirements"

END OF SECTION

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

B. Related Section:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products 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."

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   1. Standards: ASTM C 1277 and CISPI 310.
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   1. Standards: ASTM C 1277 and ASTM C 1540.
   2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.
1. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer 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. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement 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."

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
a. Standard: ASTM C 1173.
b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. 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.

4. Shielded, Nonpressure Transition Couplings:
a. Standard: ASTM C 1460.

b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

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

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

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

H. 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.

I. 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.

J. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Vent Piping: 1 percent slope down toward vertical fixture vent or toward vent stack.

K. 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."

L. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

M. Install aboveground PVC piping according to ASTM D 2665.

N. Install underground PVC piping according to ASTM D 2321.

O. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.

3.5 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] 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 (4.5 m).

G. 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.

H. Install supports for vertical copper tubing every 10 feet (3 m).

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 48 inches with 3/8-inch rod.
2. NPS 3 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8 48 inches with 3/4-inch rod.

J. Install supports for vertical PVC piping every 48 inches

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 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.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 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.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, waste piping NPS 8 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, vent piping NPS 4 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, soil, waste, and vent piping NPS 8 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Roof flashing assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.
7. Grease interceptors.
8. Can Wash Drain

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
      g. Or approved equal.:
   2. Standard: ASME A112.14.1.
   3. Size: Same as connected piping.
   4. Body: Cast iron.
   5. Cover: Cast iron with bolted or threaded access check valve.

6. End ConnectionsHub and spigot or hubless
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
   e. Or approved equal.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

A. Exposed Cast-Iron Floor Cleanouts
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for cast ironfor cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk brass cast-ironplug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.

4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, chrome-plated bronze or stainless-steel cover plate with screw.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Commercial Enameling Co.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Prier Products, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. Or approved equal
2. Standard: ASME A112.6.3
3. Pattern: Floor drain.
4. Body Material: Gray iron
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Epoxy Coated
11. Sediment Bucket: Slotted Sediment Bucket.
12. Top of Strainer Material: Nickel bronze in toilet rooms (FD-1) and Cast iron in equipment rooms (FD-2)
13. Top of Body and Strainer Finish: Nickel bronze in toilet rooms (FD-1) and Cast iron in equipment rooms (FD-2)
14. Top Shape: Round
15. Top Loading Classification: Medium Duty for FD-1 and Heavy Duty for FD-2.
16. Funnel: Not required
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
18. Trap Material: Cast iron
19. Trap Pattern: Standard P-trap.
20. Trap Features: Cleanout and trap-seal primer valve drain connection.

2.4 ROOF FLASHING ASSEMBLIES

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.
c. Or approved equal

2. Description: Manufactured assembly made of 4.0-lb/sq. ft 0.0625-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.
b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

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.

B. 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.

C. 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.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

F. Vent Caps

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft. 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 GREASE INTERCEPTORS

A. Grease Interceptors
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or as detailed on the drawing:
   a. Applied Chemical Technology, Incorporated.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Rockford Sanitary Systems, Inc.
   e. Schier Products Company.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Light Commercial Operation.
   j. Zurn Plumbing Products Group; Specification Drainage Operation
   k. Or approved equal.
2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation wastewater.
3. Plumbing and Drainage Institute Seal: Not required
4. Body Material: Steel for indoor application and coated steel or concrete for outdoor underground application.
5. Interior Lining: Not required
6. Exterior Coating: Corrosion-resistant enamel.

7. Body Dimensions: As indicated on drawings.
8. Body Extension: Provide where required
9. Inlet and Outlet Size: as shown in drawing
10. End Connections: Flanged, Hub, or Threaded.
11. Cleanout: Integral or field installed on outlet.
12. Mounting: above floor or underground as indicated.
13. Flow-Control Fitting: Required.
14. Operation: Manual cleaning.

2.8 CAN WASH DRAIN

A. Basis of Design: Subject to compliance with requirements, provide ZURN Model Z-1982-WB or comparable products by one of the following:
   a. Acorn Engineering Company.
   b. Watts Drainage Products Inc
   c. Josam Company; Josam Div.

B. Description: 12" x 12" x 8" deep fabricated type 304 stainless steel body with bottom outlet, anchor pan, medium duty stainless steel loose set grate, with standing sediment bucket. Complete with chrome plated bronze spray nozzle and water supply assembly along with a water supply shut-off valve control box. Water supply control box assembly shall be fabricated type 304stainless steel with cylinder lock and hinged cover, containing control valve with vacuum breaker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. 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.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. 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.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Assemble open drain fittings and install with top of hub 2 inches above floor.

I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

J. 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.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 14 13 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following storm drainage piping inside the building.
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.

1.3 SUBMITTALS

A. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ASTM A 74, Service class.
   1. Gaskets: ASTM C 564, rubber.

B. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
      a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
      b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

C. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

D. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.
1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Aboveground storm drainage piping NPS 10-and smaller shall be the following:
1. Solid-Wall PVC Pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground storm drainage piping NPS 10 and smaller shall be the following:
1. Solid-Wall PVC Pipe, PVC socket fittings, and solvent-cemented joints.

3.2 PIPING INSTALLATION

A. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall.

C. Install wall-penetration-fitting system at each service pipe penetration through foundation wall. Make installation watertight.

D. 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."

E. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building drain 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.

G. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Install backwater valves in accessible locations.
   3. Backwater valve are specified in Division 22 Section "Plumbing Specialties."

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller 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. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 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: 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.
7. NPS 6: 12 feet with 3/4-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. 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 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

B. Connect storm drainage piping to roof drains and storm drainage specialties.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction.

3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Flashing materials.
7. Downspout Nozzle

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron
3. Dimension of Body: Nominal 14 to 16 inches diameter.
4. Combination Flashing Ring and Gravel Stop Required.
5. Flow-Control Weirs: Not required
6. Outlet: Bottom
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Expansion Joint: Required.
10. Sump Receiver Plate: Not required
11. Dome Material: Cast iron
12. Perforated Gravel Guard: Stainless steel.
13. Vandal-Proof Dome: Required.
14. Water Dam: Not required

B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: 8- to 12-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Flow-Control Weirs: Not required
6. Outlet: Bottom.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Expansion Joint: Not required.
10. Sump Receiver Plate: Not required
11. Dome Material: Cast iron.
12. Wire Mesh: Not required.
13. Perforated Gravel Guard: Stainless steel
14. Vandal-Proof Dome: Required.
15. Water Dam: Not required.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: 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.
6. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.

2.4 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves

1. Standard: ASME A112.14.1, for backwater valves.
2. Size: Same as connected piping.
3. Body Material: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Hub and spigot or hubless.
6. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
7. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.5 TRENCH DRAINS

A. Trench Drains:

1. Standard: ASME A112.6.3, for trench drains.
2. Body Material: Cast iron.
3. Flange: Anchor with weep holes.
4. Clamping Device Required.
5. Outlet: Bottom End as required
6. Grate Material: Ductile iron or gray iron.
7. Grate Finish: Not required.
8. Dimensions of Frame and Grate: as required.
9. Top-Loading Classification: Heavy Duty.

2.6 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.

B. 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.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

2.7 DOWNSPOUT NOZZLE

A. Cast-bronze or Nickel bronze body with threaded inlet for pipe size indicated and loose cast bronze wall flange with mounting holes. Provide Nickel bronze finish. Provide bird screen.

B. Manufacturer: Subject to compliance with requirements, provide Josam Series 25010 or comparable product by one of the following manufacturers:
   1. Zurn Industries, Inc.
   2. MIFAB Co.
   3. Rockford Sanitary Systems, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 18 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

   1. Use cleanouts the same size as drainage piping up to NPS 4 Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install test tees in vertical conductors and near floor.

J. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

K. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

L. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. 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 the pipe size, with a minimum length of 10 inches and with 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. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible sump pumps.

1.2 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sump pumps that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion – Five (5) years.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible Sump Pump For Elevator Pit, (SP-1):
1. Manufacturer: Subject to compliance with requirements, provide Stancor Model SE-100 submersible effluent pump or approved equal by one of the following:
a. Federal Pumps
b. Goulds Pump

c. Sterling Peerless
d. Weil Pump Co.

2. Description: Factory-assembled and -tested simplex sump-pump unit complete with oil detection system and capable of pumping water while containing oil.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3. with oil sensor.
4. Pump Casing: Stainless steel, with stainless steel inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 532/A 532M, abrasion-resistant cast iron design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Oil Sensor Probe: Hermetically sealed, heavy duty, self-cleaning,
9. Motor: Hermetically sealed; capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

10. Controls:

    a. Enclosure: Type 4X wall-mounted, with controls approved to UL508 standards.
    b. Switch Type: Integral float switches for pump on-off and high-water alarm.
    c. Control Panel: With selector switch, pilot lights, audio-visual alarms, control transformer, and additional contacts for remote alarm bell and BAS interface.

11. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System (BAS) Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.
        3) Provide a solid state push to test switch to perform all pump and control diagnostic tests.

B. Submersible Sump Pump For Area Drains, (SP-2):
1. Manufacturer: Subject to compliance with requirements, provide Stancor Model SEW-150 submersible wastewater pump or approved equal by one of the following:
    a. Federal Pumps
    b. Goulds Pump
    c. Sterling Peerless
    d. Weil Pump Co.

2. Description: Factory-assembled and -tested simplex sump-pump unit with legs that elevate pump to permit flow into impeller, and vertical discharge for discharge piping connection.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Casing: Grey cast iron, ASTM A-48, Class 30 or stainless steel, with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be AISI-type 304 stainless steel.
5. Impeller: Statically and dynamically balanced, non-clogged, vortex design, capable of passing a 2" diameter spherical solid, Grey cast iron, ASTM A-48, Class 30 design for clear wastewater handling, and keyed and secured to shaft by a stainless-steel impeller nut.
6. Pump and Motor Shaft: 410 stainless steel, with factory-sealed, permanently grease lubricated ball-bearings.
7. Seal: Mechanical type.
8. Motor: The motor housing shall be AISI type 304 stainless steel. The motor shall be of the squirrel-cage induction design with copper windings, housed in an air filled, water tight chamber, with built-in overload protection. Provide waterproof power cable of length required.

9. Controls:

    a. Enclosure: Type 4X wall-mounted, with controls approved to UL508 standards.
    b. Switch Type: Integral float switches for pump on-off and high-water alarm.
    c. Control Panel: With selector switch, pilot lights, audio-visual alarms, control transformer, and additional contacts for remote alarm bell and BAS interface.

10. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System (BAS) Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.
        3) Provide a solid state push to test switch to perform all pump and control diagnostic tests.

2.2 SUMP PUMPS CAPACITIES AND CHARACTERISTICS

A. Unit Load Demand Characteristics:

1. As scheduled on the drawing

B. Unit Electrical Characteristics:

1. As scheduled on the drawing

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section -"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 1.3.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pump Installation Standard: Comply with HI 1.4 for installation of sump pumps

B. Sump Pump Installation:

1. Install pump in accordance with manufacturer's recommendations
2. Provide check valve and ball valve on pump discharge piping.
3. Provide required size schedule 40 PVC conduit with long radius bends between pump and control panel for power cable, and controls wiring.
4. Provide water-tight pipe sleeve at all elevator shaft wall penetrations.
5. Install electrical connections for power, controls, and devices
6. Connect pump controls to BAS system for controls interface as described under Part II of this specification section.

3.2 ADJUSTING

A. Adjust sump pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Set pump controls for automatic start, stop, and alarm operation.

C. Adjust controls set points in accordance with manufacturer's recommendations.

3.3 DEMONSTRATION

A. Train Owner's maintenance/operation personnel to adjust, operate, and maintain pump and controls.

3.4 COMMISSIONING

A. Provide support for commissioning activities and functional performance testing as outlined in specification section 019113 "General Commissioning Requirements"

END OF SECTION

SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Condensing, Commercial, gas-fired, domestic-water heaters.
2. Commercial, gas-fired, Tankless, domestic-water heaters
3. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. Sustainable Design Submittals:

C. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to Baltimore City.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.

a. Condensing, Commercial, gas-fired, Domestic-Water Heaters:

1) Heat Exchanger: Five years.
2) Controls and Other Components: Two years.
3) Separate Hot-Water Storage Tank: Five years.

b. Commercial, gas-fired, Tankless, Domestic-Water Heaters:

1) Heat Exchanger: Ten years.
2) Controls and Other Components: Five years.

c. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, DOMESTIC-WATER HEATERS

A. Condensing, Commercial, Gas-Fired, Domestic-Water Heaters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Aerco
   b. Fulton
   c. Lochinvar

2. Standard: ANSI Z21.13/CSA 4.9 for hot-water-supply boilers.
3. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.
4. Boiler Construction: ASME code with 160-psig working-pressure rating for hot-water-boiler-type, domestic-water heater. Unit shall be designed for 96% Thermal efficiency,

firing rate modulation of 5:1, less than 20 ppm NOx, and direct vent flexibility to 100 feet. Provide ASME pressure and temperature relief valve.

a. Heat Exchanger: All welded stainless steel construction to ASME standard with 160 PSIG working pressure. Provide direct spark ignition.
b. Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

5. Boiler Appurtenances:

a. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
b. Jacket: Steel with enameled finish.
c. Burner: For use with gas-fired, domestic-water heaters and natural-gas fuel.
d. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, intermittent electronic-ignition system.
e. Temperature Control: Adjustable, storage-tank temperature-control fitting and flow switch, interlocked with building water circulating pump(s) and burner.
f. Safety Control: Automatic, high-temperature-limit cutoff device or system.

6. Support: Coated structural steel base.
7. Venting: Direct outside air intake and vent flexibility to 100 feet.
8. Hot-Water Storage Tank: Connected with piping to circulating pump and domestic-water heater.

a. Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig working-pressure rating.
b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

9. Factory-Installed Storage-Tank Appurtenances:

a. Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
b. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
c. Jacket: Steel with enameled finish.
d. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-

pressure rating. Select one relief valve with sensing element that extends into storage tank.

10. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig minimum working-pressure rating, and 225 deg F continuous-water-temperature rating.
11. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.

B. Capacity and Characteristics:

1. Hot-Water Storage-Tank Capacity: As scheduled on drawing.
2. Recovery: As scheduled on drawing.
3. Temperature Setting: 125 deg F (Adjustable**)**
4. Fuel Gas Demand: As scheduled on drawing.
5. Fuel Gas Input: As scheduled on drawing.
6. Gas Pressure Regulator:

    a. Minimum Inlet Pressure: 5.0 inches water column
    b. Maximum Inlet Pressure:14.0 inches water column

7. Electrical Characteristics:

    a. Volts: 120.
    b. Phase: Single.
    c. Hertz: 60.

8. Vent Diameter: As scheduled on drawing

9. Air Inlet Diameter: As scheduled on drawing

2.2 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, Tankless, Domestic-Water Heaters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product scheduled on Drawings or a comparable product by one of the following
    a. Aerco
    b. Fulton
    c. Smith A.O Corporation
2. Description: Ultra-low NOx condensing, tank-less water heater with 0.95 energy factor. Primary heat exchanger constructed from commercial grade copper and secondary heat exchanger is constructed from type 316L stainless steel. Unit shall be Energy Star Rated. Provide electronic ignition, built-in temperature controller and system diagnostics to simplify troubleshooting.
3. Standard: ANSI Z21.10.1/CSA 4.1.
4. Storage-Tank Construction: Steel.

    a. Tappings: ASME B1.20.1 pipe thread.
    b. Pressure Rating: 150 psig.
    c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.

B. Capacity and Characteristics:

1. Capacity: As scheduled on drawing.
2. Recovery: As scheduled on drawing.
3. Temperature Setting: As scheduled on drawing.
4. Fuel Gas Demand: As scheduled on drawing..
5. Fuel Gas Input: As scheduled on drawing.
6. Gas Pressure Regulator:

    a. Minimum Inlet Pressure: 5.0 inches water column .
    b. Maximum Inlet Pressure:10.5 inches water column

7. Electrical Characteristics:

    a. Volts: 120.
    b. Phase: Single.
    c. Hertz: 60.

8. Vent Diameter: As scheduled on drawing

9. Air Inlet Diameter: As scheduled on drawing.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tank:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following
    a. AMTROL, Inc.
    b. Flexcon A.O Corporation
    c. Pentair Pump Group
    d. Smith A.O Corporation
    e. State Industries
    f. Taco, Inc
2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics:

    a. Working-Pressure Rating: 125 psig.
    b. Tank Volume: 7.8 gal. minimum
    c. Acceptance Volume: 2.5 gal. max**.**
    d. Air Precharge Pressure:40 PSI (Adjustable).

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 2-psig pressure rating as required to match gas supply.

F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.

2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.13 "Butterfly Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

G. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

H. Fill domestic-water heaters with water.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. 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 commercial, gas-fired**,** domestic-water heaters.

3.6 COMMISSIONING

A. Provide support for commissioning activities and functional performance testing as outlined in specification section 019113 "General Commissioning Requirements"

END OF SECTION

SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

A. Water Closets, WC-1:
1. Floor mounted, bottom outlet, top spud: Basis of Design Manufacturer: Subject to compliance with requirements, provide ZURN Model Z5655-BWL or approved equal by one of the following:
   a. Acorn Engineering.
   b. American standard.
   c. Bradley Corporation.
   d. Commercial Enameling Co.
   e. Crane Co.
   f. Ejer
   g. Elkay Manufacturing Co.
   h. Haws Corp., Just Co.
   i. Kohler Co.
2. Bowl:
   a. Standards: ASME A112.19.2, ASME A112.19.5.
   b. Material: Vitreous china, Acid Resistant.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.

e. Height: Standard adult, 15 inches.
f. Rim Contour: Elongated.
g. Water Consumption: 1.28 gal per flush.
h. Spud Size and Location: NPS 1-1/4"; top.
i. Color: White.

3. Bowl-to-Drain Connecting Fitting: ASME A112.4.3.
4. Flushometer Valve: Manual
5. Toilet Seat: Solid plastic, water-closet bumpers and hardware

B. Water Closet WC-2: Same as WC-1 except: Basis of Design is ZURN Model Z5665-BWL, adult ADA compliant, 17inches high.

2.2 FLUSHOMETER VALVES.

A. Lever-Handle, Diaphragm Flushometer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
a. Delaney Flush valves
b. Sloan valve Co.
c. Zurn Plumbing Products.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed
9. Consumption: 1.28 gal. per flush.
10. Minimum Inlet: NPS 1
11. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
a. Bemis, Beneke Corp.
b. Church seats
c. Olsonete Co.
d. Sperzel.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial Heavy duty.
5. Shape: Elongated rim, open front.
6. Hinge: Stainless steel, Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

B. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.

C. Install toilet seats on water closets.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements.

E. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.2 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.3 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

3.4 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 13.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Urinals.
2. Flushometer valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. UR-1: Urinals Wall hung, back outlet, siphon jet, accessible.
1. Manufacturers: Subject to compliance with requirements, provide American Standard Washbrook Flowise 6590.001 or approved equal by one of the following:
   a. Acorn Engineering.
   b. Crane Co.
   c. Ejer
   d. Kohler Co.
   e. Zurn Plumbing Products
2. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet, with extended shields.
   d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
   e. Water Consumption: Low.
   f. Spud Size and Location: NPS 3/4 top.
   g. Outlet Size and Location: NPS 2 back.
   h. Color: White

3. Flushometer Valve: Manual
4. Waste Fitting:

    a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    b. Size: NPS 2.

5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture
6. Urinal Mounting Height: Standard Child Handicapped/elderly according to ICC A117.1.

B. UR-2: Urinal Wall hung, back outlet, washout, accessible.
1. Same as UR-1 except, mount at ADA height.

2.2 URINAL FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:
1. Manufacturers Subject to compliance with requirement products by one of the following:
    a. Delaney Flush Valves
    b. Sloan Valve Co.
    c. Zurn Plumbing Products.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Consumption: 0. 125 gal per flush.

2.3 SUPPORTS

A. Type I Urinal Carrier:
1. Manufacturers Subject to compliance with requirement products by one of the following:
    a. Josam Mfg.Co.
    b. J.R. Smith
    c. Zurn Plumbing Products
2. Standard: ASME A112.6.1M.

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 urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

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

3.2 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
5. Install trap-seal liquid in waterless urinals.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lavatories.
2. Faucets.
3. Supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED LAVATORIES

A. Lavatory L-1:

1. Basis of Design Manufacturer: Subject to compliance with requirements, provide Kohler Model K-2868 or approved equal by one of the following:
   a. Acorn Engineering.
   b. American standard.
   c. Bradley Corporation.
   d. Crane Co.
   e. Ejer

2. Fixture: Cast Iron with acid-resistant enamel, wall mounted, with back
    a. Standard: ASME A112.19.2.
    b. Type: For wall hanging.
    c. Nominal Size: Rectangular, 20 inches by 18 inches or as indicated on architectural drawings.
    d. Faucet-Hole Punching: Three holes, 4-inch on center and centered on the deck.
    e. Faucet-Hole Location: Top.
    f. Color: White
    g. Mounting Material: Chair carrier.
3. Faucet: Solid-Bras, Manually Operated Faucet.
4. Support: Type II, concealed-arm lavatory carrier.
5. Mounting Height: Standard adult.

B. Lavatory L-2: Same as L-1 but ADA compliant.
1. Fixture: Cast Iron with acid-resistant enamel, wall mounted, with back
    a. Standard: ASME A112.19.2.
    b. Nominal Size: Rectangular, 20 inches by 18 inches or as indicated on architectural drawings
    c. Faucet-Hole Punching: Three holes, 4-inch on center and centered on the deck.
    d. Faucet-Hole Location: Top.
    e. Color: White.
    f. Mounting: For concealed-arm carrier. Mount at standard adult ADA height.
2. Faucet: Solid-Brass, Manually Operated Faucet
3. Support: Type II, concealed-arm lavatory carrier with escutcheons. Include rectangular, steel uprights.

C. Lavatory Faucets: Polished chrome-plated solid-brass, manual-type, 8" widespread metering faucet with centerline cast brass low profile spout, slow closing metering cartridges, and vandal-resistant ADA compliant color-coded metal handles. Basis of design is ZURN Model Z867R0-XL.
1. Standard: ASME A112.18.1/CSA B125.1.
2. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching. Coordinate outlet with spout and fixture receptor.
3. Body Material: Commercial, solid brass.
4. Finish: Polished chrome plate.
5. Maximum Flow Rate: 0.35 gpm
6. Flow Adjustment: Provide easily adjustable cycle time. Provide water conserving aerator capable of reducing flow to 0.25 gal per metering cycle.
7. Mounting Type: Deck, exposed. Provide mounting hardware and ½" coupling nuts for standard lavatory risers.
8. Spout: Rigid type.
9. Spout Outlet: Aerator
10. Operation: Compression, manual.

2.2 SUPPORTS

A. Type II Lavatory Carrier:

1. Standard: ASME A112.6.1M.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key Wheel handle.

F. Risers:

1. NPS 3/8.
2. Chrome-plated riser.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-(0.83-mm-) thick brass tube to wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories and counters and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

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 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Service sinks.
2. Classroom sinks.
3. Sink faucets.
4. Supply fittings.
5. Waste fittings.
6. Supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 SERVICE SINKS

A. Mop Sinks, MS-1:

1. Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products
   c. Florestone Products Co.
   d. Kohler Co.
   e. Precast Terrazzo Products, Inc.

2. Description: One-piece, precast terrazzo made of marble chips in compressed Portland cement to produce a compressive strength not less than 3000 PSI seven days after casting, mop service, floor mounted.

a. Standard: Comply with ASME A112.18.3M, ASSE 1011.
b. Size: 24 inches by 24 inches by 6 inches deep or as indicated on architectural drawing
c. Color: Provide color chart for selection by architect.
d. Drain: Grid with NPS 3 outlet, made of stainless steel and replaceable or integrally cast in sink.
e. Rim Guard: Stainless steel, on all top surfaces.

3. Mounting: On floor and flush to wall.

4. Faucet: Speakman SC-5811-RCP or approved equal by one of the following:

a. American Standard, Inc.
b. Chicago Faucet Co.
c. Crane Plumbing.
d. Delta
e. Kohler

B. Faucet Description: Widespread, with integral vacuum breaker, cast brass with supplies on 8-inch centers. Wall mounted and centered on fixture with pail hook, top brace and hose-threaded outlet.

2.2 CLASSROOM SINKS

A. Classroom Sink, S-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model DRKADQ2522, Stainless Steel Sink, complete with vandal resistent faucet and bubbler or comparable products by one of the following:

a. American Standard
b. Kohler Company
c. Or approved equal.

2. Standard: Comply with ASME A112.18.1, ASME A112.18.2, ASME A112.19.3, and NSF 372.
3. Fixture Description: Self-rimming, Type 304, 18 gauge stainless steel sink, single compartment with overall dimension of 25" long x 22" wide x 6" deep bowl. Exposed surfaces finished to #4 satin finished. Underside fully treated with sound deadening coating.
4. Bubbler Mounting: On right of fixture deck, centered 3" from front edge.
5. Faucet Mounting: Centered on left of fixture deck.
6. Faucet Body Material: Commercial, solid brass, with polished chrome plate finish.
7. Faucet Components: Include the following:
   a. Accessible-Fixture Operation: Manual.
   b. Handle: Two indexed-lever handles, 8 inches on center, with water mixing valve.
   c. Spout Outlet: Limited 120 degree swing or rigid gooseneck with aerator.
   d. Maximum Flow Rate: 0.5 GPM.
8. Supply Inlets: 1/2-inch NPS, brass pipe or copper tubing.
9. Supply Stops: Manufacturer's standard brass, angle or straight, compression, same size as supply inlet and with outlet matching supply riser.
10. Drain: 3-1/2-inch drain opening with grid strainer and 1-1/2-inch NPS tubular stainless-steel tailpiece.

B. Clasroom Room Sink, S-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model LR2521, Stainless Steel Sink complete with vandal resistent faucet and bubbler or comparable products by one of the following:
    a. American Standard
    b. Kohler Company
    c. Or approved equal.
2. Standard: Comply with ASME A112.18.1, ASME A112.18.2, ASME A112.19.3, and NSF 372
3. Fixture Description: Self-rimming, Type 304, 18 gauge stainless steel, single compartment with overall dimension of 25" long x 21-1/4" wide x 7-5/8" deep bowl. Exposed surfaces finished to #4 satin finished. Underside fully treated with sound deadening coating.
4. Faucet Mounting: Centered on back of fixture deck.
5. Faucet Body Material: Commercial, solid brass, with polished chrome plate finish
6. Faucet Components: Include the following:
    a. Accessible-Fixture Operation: Manual.
    b. Handle: Two indexed-lever handles, 8 inches on center, with water mixing valve.
    c. Spout Outlet: Limited 120 degree swing or rigid gooseneck with aerator.
    d. Maximum Flow Rate: 0.5 GPM
7. Supply Inlets: 1/2-inch NPS, brass pipe or copper tubing.
8. Supply Stops: Manufacturer's standard brass, angle or straight, compression, same size as supply inlet and with outlet matching supply riser.
9. Drain: 3-1/2-inch drain opening and 1-1/2-inch NPS stainless-steel or copper tailpiece with offset drain pipe in coordination with ADA accessible cabinet where necessary.

C. Science Lab Sink,S-3:

1. Furnished under architectural specification Division. Provide rough-in and final connections.
2. Faucet Mounting: Centered on back of fixture deck.
3. Faucet Components: Same as for Sink S-2 above.
4. Supply Inlets: 1/2-inch NPS, brass pipe or copper tubing.
5. Supply Stops: Manufacturer's standard brass, angle or straight, compression, same size as supply inlet and with outlet matching supply riser.
6. Drain: 3-1/2-inch drain opening and 1-1/2-inch NPS stainless-steel or copper tailpiece with offset drain pipe in coordination with ADA accessible cabinet where necessary. Provide top access solids trap with removeable stainless steel bucket-(Basis of design is Zurn Model Z-1180).

D. Science Lab Sink,S-4: Same as for sink S-3 above, except of different size and ADA compliant. See architectural specification Division for details. Provide rough-in, faucet, and final connections same as for sink S-3, including solids trap

E. Science Lab Sink,S-5: Same as for sink S-3 above, except of different size. See architectural specification Division for details. Provide rough-in, faucet, and final connections same as for sink S-3, including solids trap

F. Art Room Sink, S-6 & S-6A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model LR2521, Stainless Steel Sink or comparable products by one of the following:

    a. American Standard
    b. Kohler Company
    c. Or approved equal.

2. Standard: Comply with ASME A112.18.1, ASME A112.18.2, ASME A112.19.3, and NSF 372
3. Fixture Description: Self-rimming, Type 304, 18 gauge stainless steel, single compartment with overall dimension of 25" long x 21-1/4" wide x 7-5/8" deep bowl. Exposed surfaces finished to #4 satin finished. Underside fully treated with sound deadening coating.
4. Faucet Mounting: Centered on back of fixture deck.
5. Faucet Body Material: Commercial, solid brass, with polished chrome plate finish
6. Faucet Components: Include the following:

    a. Accessible-Fixture Operation: Manual.
    b. Handle: Two indexed-lever handles, 8 inches on center, with water mixing valve.
    c. Spout Outlet: Limited 120 degree swing or rigid gooseneck with aerator.
    d. Maximum Flow Rate: 0.5 GPM

7. Supply Inlets: 1/2-inch NPS, brass pipe or copper tubing.
8. Supply Stops: Manufacturer's standard brass, angle or straight, compression, same size as supply inlet and with outlet matching supply riser.
9. Drain: 3-1/2-inch drain opening and 1-1/2-inch NPS stainless-steel or copper tailpiece with offset drain pipe in coordination with ADA accessible cabinet where necessary. Provide top access solids trap with removeable stainless steel bucket-(Basis of design is Zurn Model Z-1180).

G. Tech Lab Sink, S-7:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model LR2219, Stainless Steel Sink or comparable products by one of the following:

    a. American Standard
    b. Kohler Company
    c. Or approved equal.

2. Standard: Comply with ASME A112.18.1, ASME A112.18.2, ASME A112.19.3, and NSF 372
3. Fixture Description: Self-rimming, Type 304, 18 gauge stainless steel, single compartment with overall dimension of 22" long x 19-1/2" wide x 7-5/8" deep bowl. Exposed surfaces finished to #4 satin finished. Underside fully treated with sound deadening coating.
4. Faucet Mounting: Centered on back of fixture deck.
5. Faucet Body Material: Commercial, solid brass, with polished chrome plate finish
6. Faucet Components: Include the following:

    a. Accessible-Fixture Operation: Manual.
    b. Handle: Vandal resistant 4 inch wrist blases handles with color-coded indexe handles, 8 inches on center, with thermostatic water water mixing valve.
    c. Spout Outlet: Rigid gooseneck.

d. Maximum Flow Rate: 0.5 GPM.

7. Supply Inlets: 1/2-inch NPS, brass pipe or copper tubing.
8. Supply Stops: Manufacturer's standard brass, angle or straight, compression, same size as supply inlet and with outlet matching supply riser.
9. Drain: 3-1/2-inch drain opening and 1-1/2-inch NPS stainless-steel or copper tailpiece with offset drain pipe in coordination with ADA accessible cabinet where necessary.

H. Exam Room Sink, S-8:

1. Same as for sink S-7 above, including faucet and accessories.

I. General Purpose Sink, S-9:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model LR2521, Stainless Steel Sink or comparable products by one of the following:

   a. American Standard
   b. Kohler Company
   c. Or approved equal.

2. Standard: Comply with ASME A112.18.1, ASME A112.18.2, ASME A112.19.3, and NSF 372
3. Fixture Description: Self-rimming, Type 304, 18 gauge stainless steel, single compartment with overall dimension of 25" long x 21-1/4" wide x 7-5/8" deep bowl. Exposed surfaces finished to #4 satin finished. Underside fully treated with sound deadening coating.
4. Faucet Mounting: Centered on back of fixture deck.
5. Faucet Body Material: Commercial, solid brass, with polished chrome plate finish
6. Faucet Components: Include the following:

   a. Accessible-Fixture Operation: Manual.
   b. Handle: Two indexed-lever handles, 8 inches on center, with water mixing valve.
   c. Spout Outlet: Limited 120 degree swing or rigid gooseneck with aerator.
   d. Maximum Flow Rate: 0.5 GPM

7. Supply Inlets: 1/2-inch NPS, brass pipe or copper tubing.
8. Supply Stops: Manufacturer's standard brass, angle or straight, compression, same size as supply inlet and with outlet matching supply riser.
9. Drain: 3-1/2-inch drain opening and 1-1/2-inch NPS stainless-steel or copper tailpiece with offset drain pipe in coordination with ADA accessible cabinet where necessary.

J. Kitchen Sink, KS-1:

1. Same as for sink S-9 above.

K. Utility Sink, US-1

1. Basis of Design: Subject to compliance with requirements, provide Elkay Model SS8124 or approved equal product by one of the following:
   a. Just Manufacturing Co.
   b. Kohler Co.
   c. Dayton Products, Inc.

2. Description: Single-compartment scullery sink without drainboard, fabricated from 14-gauge type 304 stainless-steel. Exposed surfaces finished to #4 satin finished. Underside fully treated with sound deadening coating. Sink supported on four (4) 1-5/8" diameter, tubular, #16 gauge stainless steel adjustable legs. Sink compartment pitched to drain.
   a. Overall Dimensions: L=27" x W=24" x bowl depth = 14". Full length 8" high back-splash. Height of legs approximately 22".
   b. Supplies: NPS 1/2 chrome-plated copper with stops.
   c. Drain Opening: 3-1/2".
   d. Faucet holes: Two 1-1/2" diameter on back-splash, 8" on center. Provide faucet as selected by architect.
   e. Drain Piping: NPS 2 chrome-plated, cast-brass P-trap; 0.045-inch-thick tubular brass waste to wall; and wall escutcheon.
3. Sink faucet: Subject to compliance with requirements, provide wall mounted 8" fixed centers hot and cold water workboard sink faucet. Chrome plated solid brass construction, 4" metal vandal proof wristblade handles, with secured red and blue buttons and ceramic quarter turn cartridge. Provide Chicago Faucets Model W8W-GN2AE1-317ABCP or approved equal.

2.3 CLASSROOOM SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Manual type, two-lever-handle, widespread, mixing valve. Basis of design Manufacturers: Subject to compliance with requirements, provide Zurn Plumbing Products Model Z831B1-XL-ICT or approved equal by one of the following:
   a. Speaksman.
   b. T & S Brass and Bronze Work Inc.
   c. Chicago Faucets.

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, two holes.
5. Body Material: Commercial, solid brass
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm
8. Handle(s): Lever or Wrist blade.
9. Mounting Type: Deck, exposed.
10. Spout Type: Rigid, gooseneck.
11. Vacuum Breaker: Not Required.
12. Spout Outlet: Aerator.

2.4 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water. Comply with NSF- 372.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2
2. Chrome-plated, soft-copper flexible tube.

2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "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

SECTION 22 42 23 - COMMERCIAL SHOWERS.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Individual shower receptors.
2. Shower faucets.
3. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals: Documentation indicating flow and water consumption requirements.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 INDIVIDUAL SHOWERS

A. Individual Shower, SH-1:
1. Basis- of-Design Product: Where shower enclosure is not provided under architectural work, provide Aqua Bath Model C4136BF-FUS or comparable products by one of the following:
    a. Aker Plastics Co., Inc
    b. Crane Plumbing, L.L.C./Fiat Products.
    c. Kohler Co.
    d. Sterling Plumbing Group, Inc.
2. Description: Acrylic One-piece molded accessible shower enclosure without any joints or seams and including soap dish, shower valve, faucet, receptor, and center drain.
3. Standard: ANSI Z124.1.2, ANSI A117.1, ADA compliant and NAHB Listed.
4. Type: Transfer shower with three sides and top
5. Faucet: Shower Faucets with severe service shower head
6. Maximum Flow Rate: 1.25 GPM.
7. Inside Dimension: 36 inches wide by 36 inched depth x 78 inches high.
8. Outside Dimension: 41 inches wide by 37 inched depth x 82.75 inches high
9. Color: White or manufacturer's standard color selected by architect.

10. Bathing Surface: Slip resistant according to ASTM F 462.
11. Outlet: Stainless steel drain with NPS 2 outlet.
12. Shower Rod and Curtain Hooks: Required. Provide 1 inch diameter stainless steel rod and curtain.
13. Grab Bar: Provide 18 inch 1-1/2" stainless steel vertical grab bar and 32" x 16" -1-1/2" diameter stainless steel wrap grab bar.
14. Folding Shower Seat: Required
15. Hand Held Sprayer: Required, with stainless steel hose.

B. Individual Shower, SH-2:
1. Same as SH-1 except, Non-ADA type. Provide valve control on back wall. Basis of design is Aqua Bath Model IS4136SH.

2.2 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Faucets
1. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
2. Faucet:

a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. EPA WaterSense: Required.
e. Mounting: Exposed.
f. Operation: Single-handle, push-pull or twist or rotate control.
g. Antiscald Device: Integral with mixing valve.
h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

3. Supply Connections: NPS 1/2
4. Shower Head:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Type: Ball joint with arm and flange, Ball joint and head integral with mounting flange.
c. Shower Head Material: Chrome-plated brass finish.
d. Spray Pattern: Fixed.
e. Flow rate 1.25 gpm
f. Integral Volume Control: Required.
g. Shower-Arm, Flow-Control Fitting: 1.25 gpm at 60 psi.
h. Temperature Indicator: Not required.

2.3 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 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. Exception: Use ball or gate valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping"
2. 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. Set shower receptors in leveling bed of cement grout.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. 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 079200 "Joint Sealants."

3.2 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 221116 "Domestic Water Piping."

C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.3 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.

3.4 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

SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Eyewash equipment.
2. Combination units.
3. Water-tempering equipment.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 FAUCET WITH EYEWASH COMBINATION UNITS.

A. Accessible, Plumbed gooseneck faucet with eyewash combination units (FEW-1).

1. Basis-of-Design Faucet: Subject to compliance with requirements, provide Speakman Model SEF-1800-CA or a comparable product by one of the following
   a. Chicago faucet
   b. T & S Brass and Bronze Works,Inc.
   c. Zurn Plumbing products
2. Faucet 8 inch center
3. 8 in. gooseneck spout
4. Serrated tip with vacuum breaker
5. Capacity: Not less than 0.4 gpm for at least 15 minutes.
6. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
7. Control-Valve Actuator: Paddle.
8. Spray-Head Assembly: Two receptor-mounted spray heads.
9. Receptor: Chrome-plated brass or stainless-steel bowl.
10. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2
11. Mounting: Sink deck.
12. Special Construction: Comply with ICC/ANSI A117.1.

2.2 COUNTER-MOUNTED EYEWASH WASH EQUIPMENT (CEW-1)

A. Description: Accessible, counter top mounted Eyewash Unit.
1. Basis-of-Design Emergency Eyewash: Subject to compliance with requirements, provide Speakman Model SE-927 or a comparable product by one of the following:
   a. Bradley corporation
   b. Encon Safety products
   c. Guardian equipment
   d. Haws corp
2. Capacity: 2.69 gpm at 30 psi.
3. Supply Piping: 6 ft. reinforced hose, 750 psi burst pressure, NPS 1/2 chrome-plated brass or stainless steel..
4. Control-Valve Actuator: Self-closing valve with stay-open feature and brass, chrome-plated squeeze handle activator and with flow regulator.
5. Spray-Head Assembly: Two receptor-mounted spray heads.
6. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2]
7. Special Construction: Comply with ICC/ANSI A117.1.

2.3 COMBINATION SHOWER WITH EYE/FACE WASH BOWL (SEW-1)

A. Description: Accessible, free standing shower with eyewash Unit.

1. Basis-of-Design: Subject to compliance with requirements, provide Speakman Model SE-603 or a comparable product by one of the following:
    a. Bradley corporation
    b. Encon Safety products
    c. Guardian equipment
    d. Haws corp.
2. Eye/Face Wash Feature: Multiple brass chrome-plated sprays, brass, chrome-plated in-line strainer, stainless steel bowl, stainless steel push handle activator, polypropylene shrouds, 9.3 gpm capacity, at 30 psig, ½ inch NPT female inlet, and universal emergency sign.
3. Shower Feature: 8" diameter plastic shower head; internal 20 gpm regulator flow control at 30 psig; powder coated aluminum triangular pull rod activation; stanchion made of 1-1/4 inch galvanized steel and fittings; 1-1/4 inch NPT female waste and inlet; 1 inch NPT female brass, chrome-plated full flow stay-open ball valve.
4. Special Construction: Comply with ANSI/ISEA Z358.1

2.4 WALL-MOUNTED EYEWASH WASH EQUIPMENT (WEW-1)

A. Description: Accessible, wall-mounted Eyewash Unit.
1. Basis-of-Design Emergency Eyewash: Subject to compliance with requirements, provide Speakman Model SE-580 or a comparable product by one of the following:
    a. Bradley corporation
    b. Encon Safety products
    c. Guardian equipment
    d. Haws corp
2. Capacity: 3.2 gpm at 30 psi flow rate.
3. Supply Piping: 6 ft. reinforced hose, 750 psi burst pressure, NPS 1/2 chrome-plated brass or stainless steel.
4. Control-Valve Actuator: Self-closing, chrome-plated brass valve, with stainless steel push handle activation. Provide water tempering valve.
5. Spray-Head Assembly: Two spray heads/outlets with integral flow control and flip-top dust caps.
6. Wall-Mounting Bracket: Cold-rolled steel, powder coated or stainless steel.
7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
8. Special Construction: Comply with ICC/ANSI A117.1.

2.5 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment:
1. Description: Factory-fabricated equipment with thermostatic limiting mixing valve complying with ASSE 1070.
    a. Thermostatic Mixing Valve: Designed to provide 85 deg F. tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 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, and corrosion-resistant enclosure.

b. Supply Connections: For hot and cold water.

2.6 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 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 counter-top or substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate 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 220523.12 "Ball Valves for Plumbing Piping".

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

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 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "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 221316 "Sanitary Waste and Vent Piping."

3.2 CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. 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 221116 "Domestic Water Piping."

C. 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 221316 "Sanitary Waste and Vent Piping."

D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

E. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.3 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 220553 "Identification for Plumbing Piping and Equipment."

3.4 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. 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.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 22 45 00

SECTION 22 47 16 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pressure water coolers and related components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

B. Sustainable Design Submittals:

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

D. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water cooler that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion. Three years minimum.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

1.4 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. Filter Cartridges: Equal to 20 percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

PART 2 - PRODUCTS."

2.1 PRESSURE WATER COOLERS

A. EWC-1: Pressure Water Coolers, Wall mounted, wheelchair accessible. Basis of design is Halsey Taylor Model HTHB-HAC8BLSS-WF. Features shall include:

1. Cabinet: Bi-level, with two attached cabinets, all stainless steel.
2. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
3. Control: Push buttons on front and on one side of each cabinet. Provide electronic bottle filler sensor and visual filter monitor.

4. Drain: Grid with NPS 1-1/ tailpiece.
5. Supply: NPS 3/8 with shutoff valve.
6. Waste Fitting: ASME A112.18.2, NPS 1-1/4brass P-trap.
7. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
8. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

    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.

9. Capacities and Characteristics:

    a. Cooled Water: 8 gph
    b. Ambient-Air Temperature: 90 deg F
    c. Inlet-Water Temperature: 80 deg F
    d. Cooled-Water Temperature: 50 deg F.
    e. Cooled-Water Storage: Manufacturer's standard.
    f. Electrical Characteristics:

        1) Motor Horsepower: 1/6.
        2) Volts: 120-V ac.
        3) Phase: Single.
        4) Hertz: 60.
        5) Maximum Overcurrent Protection: 15A.

10. Water Cooler Mounting Height: Standard, according to ICC A117.1.
11. Certification: Unit shall be Lead-free design and certified to NSF/ANSI 61 & 372 and meets Federal and State low-lead requirements.

B. EWC-2: Accessible Electric Water Cooler: Where plumbing fixtures of this designation are indicated, provide ADA, ANSI/NSF 61 compliant, electric water cooler with push button mechanism, touchless electronic sensor, water bottle filling and filter monitor complying with the following:

1. Products: Subject to compliance with requirements, provide:
    a. Halsey Taylor Model HTHBWF-HRFSER
    b. Or approved equal.

2. Fixture Type: Bubbler, high and low unit.
3. Fixture Unit Capacity: 8.0 G.P.H.
4. Fixture Cabinet Material: Stainless steel.
5. Fixture Mounting: Wall, semi-recessed.
6. Supply: 3/8-inch NPS copper tubing.
7. Water Filter: Manufacturer's standard
8. Cast-Brass Trap: 1-1/4-inch NPS.
9. System refrigerant type: R-134a or manufacturer's standard.

2.2 SUPPORTS

A. Type I Water Cooler Carrier:
1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set freestanding pressure water coolers on floor.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping"

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements.

G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "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 221116 "Domestic Water Piping."

C. Install ball or gate shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping"

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 01 00 - GENERAL PROVISIONS - MECHANICAL

1. GENERAL

A. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical System(s) indicated or specified in the Contract Documents.

B. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

C. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor (or Construction Manager, if applicable), responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect (if applicable), then to the Engineer. Also, this section of the specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

D. It is the intent of this Contract to deliver to the Owners a "new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

E. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

F. Definitions and Abbreviations

(1) Contractor - Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of mechanical work (Controls, Plumbing, HVAC, Sprinkler, Gas Systems, etc.) or, the General Contractor.

(2) Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.

(3) Architect - The Architect of Record for the project.

(4) Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

(5) Provide - Furnish and install complete, tested and ready for operation.

(6) Install - Receive and place in satisfactory operation.

(7) Indicated - Listed in the Specifications, shown on the Drawings or Addenda thereto.

(8) Typical - Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

(9) Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owners, etc.

(10) Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

(11) OSHA - Office of Safety and Health Administration.

(12) IBC – International Building Code

(13) The Project - All of the work required under this Contract.

(14) NEC - National Electrical Code.

(15) NFPA - National Fire Protection Association.

(16) ASME - American Society of Mechanical Engineers.

(17) AGA - American Gas Association.

(18) SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

(19) ANSI - American National Standards Institute.

(20) ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.

(21) NEMA - National Electrical Manufacturers Association.

(22) UL - Underwriters Laboratories.

(23) ADA - Americans with Disabilities Act.

(24) IMC - International Mechanical Code.

(25) IECC - International Energy Conservation Code.

(26) IFGC - International Fuel Gas Code.

2. INTENT

A. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.

B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

3. DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The drawings are not intended to show every item which may be necessary to complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.

C. The drawings and specifications shall be considered to be cooperative and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.

F. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is

to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

G. Unless dimensioned, the mechanical drawings only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work.

H. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Landscaping, Structural, Surveys, etc., to ensure that the work he intends to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.

I. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

L. Special Note: Always check ceiling heights indicated on Architectural Drawings and Schedules and ensure that they may be maintained after all mechanical and electrical equipment is installed. Do not install equipment in the affected area until the conflict is resolved.

4. EXAMINATION OF SITE AND CONDITIONS

A. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His proposal shall cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests approval of materials and/or equipment of different physical size, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, electrical services, etc., from that indicated. Any requests for Substitutions shall comply with Division 1 requirements and procedures. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.

B. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the provisions of Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineers.

D. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

6. SUPERVISION OF WORK

A. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent onsite.

7. CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, water and/or sewer system development charge, etc. in connection with his work. He shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. He shall hire an independent Registered Engineer to witness installations and provide necessary certifications where required by utility companies, municipal agencies or others that have review authority. He shall also obtain all required certificates of inspection for his work and deliver same to the Engineers before request for acceptance and final payment for the work. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The

Contractor shall also be versed in all Codes, Rules and Regulations pertinent to his part of the work prior to submission of a proposal.

B. The Contractor shall include in his work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

D. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable. Where required by the Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.

E. All plumbing work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such plans are in the hands of the Contractor.

F. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the International Building Code (IBC) and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association. Contractor shall secure a permit from the Division of HVAC. Final inspection certificate shall be provided by Contractor and a copy included in Operation and Maintenance Manuals.

8. EQUIPMENT AND PIPING SUPPORT

A. Each piece of equipment, apparatus, piping, or conduit suspended from the structure or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

9. DUCT AND PIPE MOUNTING HEIGHTS

A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure.

10. CORRECTION PERIOD

A. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of his operator or other employees. Refer to other sections for any special or extra warranty requirements.

B. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.

C. All compressors shall have five year warranty.

11. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

12. CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

13. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. SURVEY, MEASUREMENTS AND GRADE

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the contract documents, he

shall promptly notify the Engineer and shall not proceed with this work until he has received instructions from the Engineer on the disposition of the work.

15. TEMPORARY USE OF EQUIPMENT

A. The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Engineers. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.

B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

C. A pre-start-up conference shall be held with the Architect, Owner, General Contractor and the Mechanical Contractor. Equipment shall not be started until after this meeting.

D. During all phases of construction:

(1) Heat Pump Units:

a. At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.

b. On the outside of all return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the “construction” filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.

c. At substantial completion of the project the entire unit shall be cleaned to present a like “new” unit for the Owner and all filters shall be replaced with new.

(2) Outside Air Units:

a. These units shall not be used for temporary heating and cooling by the Contractor. They shall, however, be made operational, tested, etc. as specified during construction by the Contractor. Three complete sets of filters are required for each unit. In each unit, install one set of filters during construction. In each unit, install one set of filters at substantial completion. For each unit, leave third set of filters in boxes in appropriate mechanical room as a spare set for the Owner. Dispose of all construction filters.

b. At substantial completion of the project the entire unit shall be cleaned to present a like

"new" unit for the Owner and all filters shall be replaced with new.

16. TEMPORARY SERVICES

A. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

17. RECORD DRAWINGS

A. The Contractor shall ensure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these marked up plans along with a scanned electronic copy in PDF format.

18. MATERIALS AND WORKMANSHIP

A. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.

B. Materials and equipment, where applicable, shall bear Underwriters' Laboratories label where such a standard has been established.

C. Use extreme care in the selection of equipment and its installation to ensure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.

D. Each length of pipe, fitting, trap, fixture and device used in the hydronic or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.

E. All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a data plate indicating required horsepower, voltage, phase and ampacity.

19. COOPERATION AND COORDINATION WITH OTHER TRADES

A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay. Refer to Division 1 for specific coordination requirements.

B. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

20. QUALIFICATIONS OF WORKMEN

A. All mechanical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workman shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of Architect, Contractor, etc.

B. All sheet metal, insulation and pipe fitting work shall be installed by workmen normally engaged or employed in these respective trades, except where only small amounts of such work are required and are within the competency of workmen directly employed by the Contractor involved.

C. All automatic control systems shall be installed by workmen normally engaged or employed in this type work, except in the case of minor control requirements (residential type furnaces, packaged HVAC equipment with integral controls, etc.) in which case, if a competent workman is the employee of this Contractor, he may be utilized subject to review of his qualifications by the Engineer and after written approval from same.

D. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

21. CONDUCT OF WORKMEN

A. Refer to Division I requirements.

22. PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, etc., shall be properly plugged or capped during construction. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at his own expense.

23. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

24. BROKEN LINES AND PROTECTION AGAINST FREEZING

A. No conduits, piping, troughs, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. If in doubt, contact the Engineer. Do not install piping across or near openings to the outside whether they are carrying static or moving fluids or not. Special Note: Insulation on piping does not necessarily ensure that freezing will not occur.

25. CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish and debris caused by his operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may request cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

26. CONCRETE WORK

A. The Contractor shall be finally responsible for the provisions of all concrete work required for the installation of any of his systems or equipment. He may, at his option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Mechanical work shall be 3000 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be set on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into floors to anchor pads.

B. All mechanical equipment (tanks, heat pumps, pumps, air handling units, etc.) shall be set on a minimum of 4” tall concrete pads. Pads shall be taller where required for condensate traps. All concrete pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18” in width shall be reinforced with ½” round bars on 6”

centers both ways. Bars shall be approximately 3" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all square edges one-half inch.

C. In general, concrete pads for equipment shall extend four (4) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space.

D. Exterior concrete pads shall be four (4) inches minimum above grade and four (4) inches below grade on a tamped four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (1/2) inch chamfer on exposed edges.

E. All exterior below grade concrete structures (utility vaults, grease traps, manholes, etc.) shall be provided with exterior waterproofing. Waterproofing shall be hot-fluid applied rubberized-asphalt waterproofing membrane with elastomeric sheets at edges, corners, and terminations of membrane for continuous watertight construction. Apply in layers and reinforce as required to provide uniform seamless membrane minimum 4mm thickness. Also, seal penetrations into and out of the structure watertight. Provide Link-Seal modular seal or equal.

27. NOISE, VIBRATION OR OSCILLATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means. Unitary equipment, such as small room heating units, small exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineers.

28. ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.

B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, etc.

C. The Contractor shall provide access panels for each concealed valve, control damper or other device requiring service as shown on engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work.

29. MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily.

B. Utilities and lines, where known, are indicated on the drawings. Locations and sizes are approximate. Prior to any excavation being performed, the Contractor shall ascertain that no utilities or lines are endangered by new excavation. Exercise extreme caution in all excavation work.

C. If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation or blasting in the respective area.

D. Cutting into existing utilities and services where required shall be done in coordination with and only at times designated by the Owner of the utility.

E. The Contractor shall repair to the satisfaction of the Engineer, any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted with ten feet of electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only.

G. Protect all new or existing lines from damage by traffic, etc. during construction. Repairs or replacement of such damage shall be at the sole expense of the party responsible. The geothermal lines shall clearly be marked throughout the demolition of the existing facility and protected from heavy traffic and excavation. Any damage to the pipes shall be repaired at no additional cost to the Owner.

30. SMOKE AND FIRE PROOFING

A. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the IBC. Patch all openings around ductwork and piping with

appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at fire walls, floors, ceilings, roofs, etc. All fireproofing shall be UL listed for the required rating. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

31. MOTORS

A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with standards of A.S.A. C50, conforming to this and all applicable standards for insulation resistance and dielectric strength.

B. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box, and N.E.C. required disconnecting means as specified or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

C. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 26 of Specifications for further requirements related to installation of motors.

32. CUTTING AND PATCHING

A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Structural Engineer.

C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

33. CURBS, PLATES, ESCUTCHEONS & AIR TIGHT PENETRATIONS

A. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.

B. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit.

Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

C. Seal all duct, pipe, conduit, etc., penetrations through walls and floors air tight. If wall or floor assembly is rated then use similarly rated sealing method.

34. WEATHERPROOFING

A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

35. OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

A. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list of representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.

B. Refer to Division I for operations and maintenance manual requirements.

C. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.

D. The Contractor shall frame under Lexan in the main mechanical room all temperature control diagrams and all piping diagrams.

36. PAINTING

A. In general, all finish painting shall be accomplished under the Painting Section of the specifications by the Contractor; however, unless otherwise specified under other sections of these specifications, the following items shall be painted:

(1) All exposed piping, valve bodies and fittings (bare and insulated), including hangers, platforms, etc.

(2) All mechanical equipment not factory finished. Aluminum and stainless steel equipment, motors, identification plates, tags, etc. shall not be painted. All rust and foreign matter shall be thoroughly removed from surfaces prior to painting. All baked enamel factory finish of equipment which may have been scratched or chipped shall be touched up with the proper paint as recommended and supplied by the manufacturer.

(3) All ductwork exposed in finished areas (bare and insulated), all grilles, diffusers, etc. not factory finished. Paint the inside surfaces of all interior duct surfaces visible from any register, grille or diffuser opening on all jobs; surfaces shall receive one (1) prime coat of Rustoleum 1225 red "galvinoleum" or other approved equivalent primer and rust inhibitor

and one (1) coat of Rustoleum 1579 jet black "Speedy Dry" enamel or approved equivalent applied in accordance with the manufacturer's recommendations.

(4) All insulated piping, ductwork and equipment shall be properly prepared for painting by the Contractor where mechanical items are to be painted. In the case of externally insulated duct and pipe, the Contractor shall provide 6 oz. canvas jacket with fire retardant lagging. The jacket shall be allowed to dry properly before applying paint to avoid shrinking after painting and exposing unpainted surfaces. The Contractor, at his option, may provide double wall ductwork in lieu of externally insulated ductwork with canvas jacket and lagging.

37. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring thru starters, and shall furnish and install all required starters not factory mounted on equipment.

B. The Contractor shall, regardless of voltage, furnish and install all temperature control wiring and all associated interlock wiring, all equipment control wiring and conduit for the equipment that the Contractor furnishes. He may, at his option, employ at his own expense, the Electrical Contractor to accomplish this work.

C. After all circuits are energized and completed, the Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of the Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.

D. The Contractor shall furnish motor starters of the type and size required by the manufacturer for all equipment provided by him, where such starters are necessary. Starters shall have overloads for each phase.

38. FINAL CONNECTIONS TO EQUIPMENT

A. The Contractor shall finally connect to mechanical services, any terminal equipment, appliances, etc., provided under this and other divisions of the work. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer’s recommendations. If in doubt, contact the Engineers prior to installation.

39. REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost.

40. INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability

resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

41. HAZARDOUS MATERIALS

A. Refer to Division 0 for Hazardous material abatement requirements. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall ensure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

42. ABOVE-CEILING AND FINAL PUNCH LISTS

A. Refer to Division I for these requirements.

END OF SECTION

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SECTION 23 02 00- SCOPE OF THE MECHANICAL WORK

1. GENERAL

A. The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following:

(1) All mechanical exhaust systems.

(2) All insulation associated with mechanical systems.

(3) Condensate drainage systems.

(4) Complete heating, ventilation and air conditioning systems.

(5) Final connection of all mechanical equipment furnished by others (e.g., kitchen equipment).

(6) Complete balancing of air and water systems.

(7) All applicable services and work specified in Section 23 01 00; General Provisions - Mechanical.

(8) All specified or required control work.

(9) Provide all required motor starters, etc. not provided under the electrical sections.

(10) One year guarantee of all mechanical equipment, materials and workmanship starting at Substantial Completion. Extended warrantees where indicated within individual specification sections.

(11) Thorough instruction of the owner’s maintenance personnel in the operation and maintenance of all mechanical equipment.

(12) Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.

(13) Approved supervision of the mechanical work.

(14) Excavation, backfilling, cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.

(15) Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and shall include such requirements in his base bid.

(16) Procurement of all required permits and inspections, including fees for all permits and inspection services and submission of final certificates of inspection to the Engineers (Plumbing, HVAC, etc.).

(17) Factory start-up of all major equipment (including terminal HVAC equipment) and submission of associated factory start-up reports to the Engineer.

END OF SECTION

SECTION 23 03 00 - SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS & TOOLS

1. GENERAL

A. The Contractor's attention is directed also to the General and Special Conditions in Division 01 and Section 23 01 00 - General Provisions - Mechanical as well as to all other Contract Documents as they may apply to his work.

B. The Contractor shall prepare and submit to the Engineer, through the General Contractor and the Architect (where applicable) within thirty (30) days after the date of the Contract, shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter.

C. Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.

D. All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General Contractor and the Architect (if applicable) to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.

E. It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

F. The Engineers review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for: adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project. Any items that differ from the Drawings or Specifications shall be flagged by the Contractor so the Engineer will be sure to see the item. The Contractor is responsible for meeting the Drawings and Specification requirements.

G. Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.

H. If the Contractor fails to indicate in the submittal which options or features the product is provided with, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the drawings; and the Contractor shall be required to furnish all materials in accordance with this list.

I. Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors. Color samples shall be furnished with the shop drawing submission for such equipment.

J. Shop Drawing Submittals

(1) All submittals for HVAC equipment shall include all information specified. This shall include air and water pressure drops, RPM, noise data, face velocities, horsepower, voltage motor type, steel or aluminum construction, and all accessories clearly marked.

(2) All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule.

(3) All items submitted shall be designated with the same identifying tag as specified on each sheet.

(4) Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

2. SHOP DRAWINGS

Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

Duct Insulation (Internal and External)
Pipe Insulation
Hydronic Specialties
(2) Chemical Treatment System
Pumps and Circulators (HVAC)
Heat Pumps
Controls
Dedicated Outside Air Unit
HVAC Equipment
Registers, Grilles, Diffusers
Hydronics
Valves

SPECIAL NOTES:

(1) Refer to Division I requirements for operations and maintenance manuals.

(2) Shop drawings for the Control Systems shall include detailed, scaled plans and schematic diagrams indicating the function and operation of the system.
(3) The Contractor shall submit Material Safety Data sheets for all chemical treatment and anti-freeze solutions.

3. LEED

A. EA prerequisite 3/EA credit 4, Refrigerant Management: Provide manufacturer's cut sheets for all cooling equipment highlighting the type and quantity of refrigerants used, including ODP & GWP. Provide manufacturer's cut sheets indicating the absence of halons, CFCs and HCFS in the fire-suppression systems.
B. EA credit 5: Measurement and Verification: Provide cut sheets and manufacturer's product data for all controls systems, highlighting electrical metering, gas metering, water metering, and any trending capability components.
C. EQ prerequisite 1: Provide manufacturers cut sheet supplying total air flow and total outside airflow of relevant HVAC equipment.
D. EQ credit 1: Outdoor Air Delivery Monitoring: Provide manufacturer's cut sheets highlighting the installed air flow and carbon dioxide monitoring system components and sequence of controls shop drawing documentation, including CO2 differential set-points and alarm capabilities.

4. SPECIAL WRENCHES, TOOLS, ETC.

(1) The Contractor shall furnish, along with equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed under the Contract. Wrenches shall include necessary keys, handles and operators for valves, cocks, hydrants, etc. A reasonable number of each shall be furnished.

5. BALANCE REPORTS

A. Following completion of the testing, provide an electronic copy of the balance report. Upon substantial completion of the project, the Contractor shall submit to the Engineers four (4) bound hard copies of the Certified Air and Hydronic Balance Report.

END OF SECTION

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SECTION 23 05 00 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

   A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Food Service, and Structural drawings, to the end that complete coordination between trades will be affected. Special attention shall be given to the points where ducts or piping must cross other ducts or piping, where lighting fixtures must be recessed in ceilings, and where ducts, piping and conduit must fur into walls, soffits, columns, etc. It shall be the responsibility of the Contractor to leave the necessary room for other trades. No extra compensation will be allowed to cover the cost of removing piping, conduit, ducts, etc., or equipment found encroaching on space required by others.

   B. The Contractor shall be responsible for coordination with the Electrical trade to insure that he has made provision for connections, operational switches, disconnect switches, fused disconnects, etc. for electrically operated equipment provided under this division of the specifications, or called for on the plans.

   C. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other Contracts, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of piping, ductwork, conduit, and equipment not installed in accordance with the above instructions, and which interfered with work and equipment of other trades.

   D. In all areas where air diffusers and lighting fixtures are to be installed, the Contractor shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangements.

2. INTERFACING

   The Contractor shall insure that coordination is affected relative to interfacing of systems. Some interface points are (but not necessarily all):

   A. Connection of Domestic Water System to water service mains.

   B. Connection of Natural Gas System to natural gas service.

   C. Connection of Fire Protection System to domestic water service.

   D. Connection of Sanitary sewer house line to municipal service.

   E. Connection of Storm Drainage System to municipal system.

F. Connection of fuel oil piping to emergency generator.

G. Connection of Domestic Water System to Hydronic System.

H. Connection of all controls to equipment.

I. Electrical power connections to electrically operated (or controlled) equipment.

J. Connection of Emergency Engine Exhaust System.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall make all connections to equipment furnished by others, or relocated from the existing structure, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. Supervision to assure proper functioning and operation shall be provided by the Contractor.

C. Items indicated on the drawings as rough-in only (RIO) will be connected by others. The Contractor shall be responsible for rough-in provisions only.

D. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

E. The Contractor shall be responsible for coordinating to determine any and all final connections that he is to make to equipment furnished by others.

4. COORDINATION DRAWINGS AND RECORD DRAWINGS

A. COORDINATION as follows:

(1) Detailed electronic coordination drawings shall be required for this project and shall be led by the Mechanical Contractor. Refer to Division I for requirements.

(2) Coordination Drawings shall be provided on this project by each Trade (Mechanical, Fire Protection, Electrical). Drawings shall be 30 x 42 sheet size and shall be at ¼" scale and shall match the drawing setup as included in the Architectural Drawings. Refer to Division I for procedure to request electronic drawings from Architect.

(3) The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings and shall be prepared by the Mechanical Contractor. The Coordination Drawings shall indicate (1) systems above ceilings in finished areas, (2) systems supported from the structure in finished areas without ceilings, (3) systems in the mechanical rooms, and (4) all wall, roof, floor penetrations. **These drawings shall be 3-D drawings and shall be able to be reviewed with a 3-D software system such as Revit or Navisworks.**

(4) The sheet metal fabrication shop drawings shall be completed in a timely manner so as

not to conflict with construction schedule and phasing plan. At the General Contractor's discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing.

(5) Pre-Coordination Meetings with all necessary trades shall occur. During these meetings, the Contractors shall discuss locations/elevations where piping, conduits, cable trays, etc will be installed with respect to the sheet metal fabrication drawings and other trades. The sheetmetal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all conflicts can be resolved between Trades. All conflicts shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

(6) It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:

a. All ductwork including and all above ceiling equipment i.e. VAV boxes indicating appropriate maintenance access routed as indicated on the drawings. The drawings shall indicate a 3 ft. clearance zone that is unobstructed and allows access from a 2x2 ceiling tile.
b. All hydronic, plumbing, and sprinkler piping. Indicate all valves and ensure that appropriate access is provided for all valves.
c. Provide all conduits (existing or new) 2" and above. Multiple smaller conduits hung on a common trapeze hanger that is larger than 6" wide
d. All cable tray and enclosed wireway shall be indicated and shall indicate all required access.
e. All wall, roof, floor penetrations.

(7) After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to insure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall distributed electronically (on CD) to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the General Contractor, Owner, Architect and Engineer for their Records. This process shall be completed prior to starting any work.

(8) RECORD DRAWINGS - Each Contractor shall insure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on Coordination Drawings kept at the jobsite. Refer to Division I for requirements. All Coordination drawings shall be included as Record Drawings.

END OF SECTION

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SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes requirements for commissioning HVAC systems, assemblies, equipment, and components.

1. Commissioning is a third-party quality assurance process. It does not take the place of or duplicate the Contractor's quality control services required per Division 01 Section "Quality Requirements" or testing, adjusting, and balancing and other quality control testing or inspections required in individual Sections and normally the responsibility of the Contractor.

B. The following HVAC systems, equipment and components are to be commissioned on this Project:

HVAC	CxP Submittal Review	Construction Checklist	Functional Test Sampling
23 13 20 Geothermal Loop Piping System	Info Only		
23 31 00 Testing, Adjusting and Balancing			20%
23 41 00 Hydronic Pumps	Yes	Yes	100%
23 42 00 HVAC Equipment	Yes	Yes	20%
23 44 00 Metal Ducts	Yes		
23 52 00 Controls – Direct Digital	Yes	Yes	100%

C. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for definitions of terms used in this Section, and for commissioning requirements applicable to all systems, including HVAC.

D. The project is also pursing the LEED Monitoring Based Commissioning credit and the Enhanced Energy Metering credit. The contractor shall be fully responsible for all costs associated with purchasing monitoring based commissioning software and hardware and for the costs associated with a one year subscription starting at substantial completion.

1.2 INFORMATIONAL SUBMITTALS

A. Contractor Submittals and Shop Drawings: Concurrent with AE review, the Contractor will send submittals relating to systems to be commissioned to the CxP for review of compliance with the Contract Documents. Comments will be returned directly to the AE with a copy to the Owner for coordination of a final submittal review response from the AE to the Contractor. This includes all Division 23 submittals for systems referenced in 1.1 above.

B. Variable Refrigerant Flow (VRF) Systems: Factory training certificates for individual installers.

C. Product information for the Monitoring Based Commissioning Software.

1. Software:

a. How data is encrypted and coordination with firewalls to provide security from hacking.

b. Cloud server information.

c. Hardware that may be installed as part of the installation.

2. Fault Detection: Submit comprehensive list of project specific fault detection rules.

3. Analytics: Submit comprehensive list of project specific analytics.

4. Software deployment plan.

5. Cost of first annual subscription after completion of 1st year.

D. Commissioning Documentation: Submit the following information to the CxP:

1. Schedule: Schedule for completing construction checklists, pre-functional and start-up for HVAC systems, assemblies, equipment and components to be commissioned.
2. Test Equipment, Instrumentation, and Tools: Submit list of test equipment, instrumentation, and tools required to perform functional performance testing. Identify proprietary test equipment, instrumentation, and tools. Include calibration certificates for test equipment and instrumentation.
3. Checklists: Completed construction checklists, pre-functional checklists, point-to-point checklists and start-up forms for each piece of equipment or component.
4. Certificate of Readiness: Using FPT Certificate of Readiness form provided in Division 01 "General Commissioning Requirements," certify that HVAC systems, subsystems, equipment, components, and associated controls are ready for testing.
5. TAB Reports: Submit include initial draft version as soon as available and follow with final version when complete.
6. Trend reports.
7. Documentation of corrective actions for logged deficiencies.

1.3 CLOSEOUT SUBMITTALS

A. Commissioning issues reports showing resolution of issues.

1. Include correspondence or other documents related to resolution of issues.
2. List unresolved issues. Provide written explanation for why each item on the list remains unresolved. Indicate reason, if any, are exempt from the requirements for Construction Phase Commissioning Completion.

B. Training verification forms.

1.4 QUALITY ASSURANCE

A. Mockups:

1. Construction: Before installing portions of the work requiring mockups, build an integrated, static mockup using processes, techniques, assemblies, materials, equipment, and components indicated for the completed Work to demonstrate installation techniques and workmanship which result in ease of access, operability, and maintenance for HVAC systems and equipment requiring mockups in individual Sections, and the following:
   a. WSHP
   b. VRF System

2. Approval: Obtain Architect's approval and CxP review of mockup in accordance with requirements in Division 01 Section "General Commissioning Requirements". Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. General: Provide test equipment, instrumentation, and tools necessary to perform function performance testing. Use test equipment and instrumentation that has been calibrated, certified, and properly maintained.

1. Test equipment and instrumentation required to perform the commissioning shall remain the property of Contractor unless otherwise indicated.
2. Proprietary test equipment, instrumentation, and tools shall become the property of Architect at Substantial Completion.

   a. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate or perform work on its equipment.

2.2 MONITORING BASED COMMISSIONING SOFTWARE

A. Software shall be by one of the following manufacturers:

1. DataKwip

2. PointGuard

3. Other: to meet the same level of accessibility and features that DataKwip and PointGuard offer. ABP will review the contractor's alternative submissions for comparison.

B. Software shall be purchased after the approval of the controls submittal. The monitoring based commissioning software company will develop the measurement requirements, points,

sequences, energy use profiles, etc. based on the approved controls submittal, and this shall be reviewed by the CxP.

C. Contractor is responsible for all hardware and providing the necessary power and data to fully install the software. Contractor is responsible for all coordination between the software, the controls, and the Owner's facility/IT department.

D. The following capabilities shall be provided:

1. Analytics:

    a. Data Connection

    b. Data Mapping

    c. Data Tagging

    d. Trend Data Configuration Access

    e. Automated Fault Detection – Rules Configuration and Fault Access

2. Performance Analytics:

    a. Fault analysis tool

    b. Runtime tool

    c. Monthly performance reports

    d. Impact reports (cost associated with identified issues)

    e. Portfolio Performance Report

    f. Open Item reminder report/email

3. Energy Analytics

    a. Energy-Star Sync

    b. Utility bill data acquisition

    c. Site level energy insights

    d. Portfolio level energy insights

    e. Monthly Energy Report

    f. Portfolio Energy Report

    g. Project ROI Tool

4. Fault Detection analytics shall include fault detection on the following systems:
    a. Geothermal
    b. Water Source Heat Pumps
    c. Water-to-Water Heat Pump system
    d. VAVs
    e. Outside Air Unit
    f. Domestic Hot Water System
    g. Kitchen Freezer/Cooler
    h. Exhaust Fans
    i. Electric Heaters
    j. Split System ACs
5. Training shall be provided via web conference as follows:
    a. 15 days after the portal goes live
    b. 30 days after the portal goes live
    c. 60 days after the portal goes live
    d. 90 days after the portal goes live
    e. Each training session shall be 90 minutes

PART 3 - EXECUTION

3.1 COMMISSIONING AUTHORITY (CxP) RESPONSIBILITIES

A. Meetings: Attend and lead commissioning team meetings.

B. Checklists: The CxP shall develop and provide Project-specific construction checklists.

C. Monitoring Based Commissioning: CxP will develop the measurement requirements, points, sequences, energy use profiles, etc. based on the approved controls submittal. Review operations quarterly and submit reports to the owner. The CxP shall participate in all meetings held by the Monitoring Based Commissioning Software company, and shall take the prime role for active use of the software.

D. TAB Verification: The CxP shall verify testing, adjusting, and balancing of Work is complete.

E. FPT Procedures: The CxP shall develop and provide functional performance test procedures for HVAC systems, assemblies, equipment and components, including to verify operation and integration of new components in existing systems.

F. FPT Testing: The CxP shall witness functional performance testing, and record test results.

G. Commissioning Record: The CxP shall author a commissioning summary report and verify functional performance test data and certificates are included in the commissioning record.

3.2 CONTRACTOR RESPONSIBILITIES

A. Meetings: Attend and participate in commissioning team meetings.

B. FPT Testing: Perform functional performance testing for systems, assemblies, equipment, and components indicated to be commissioned, including seasonal testing.

C. Documentation: Provide information requested by the CxP.

D. Training: Participate in training for HVAC systems, assemblies, equipment and components.

E. Near-End-of-Warranty Walkthrough: Participate in the Near End-of-Warranty review meeting and walkthrough.

F. Purchase Monitoring Based Commissioning Software and associated 1-year subscription.

1. Provide all hardware required for the software, and all integration with the BMS.

2. Coordinate all work between the Monitoring Based Commissioning Software company, the controls contractor, and facility owner and their IT department.

3. Perform the coordination required to resolve firewall configuration between the Monitoring Based Commissioning Software company and the Owner's facility/IT department.

4. Respond to CxP's reports based on monitoring based software outputs and rectify issues noted for the 1st year of warranty where the issue is identified as a problem with the installation and programming that are at variance with the contract documents.

G. Monitoring Based Commissioning Software Deployment:

1. Kick-off with software company: 30 days after approval of submittal by CxP

2. Install data collection module on existing controls server and test data transfer: Within 5 days of controls contractor complete with point-to-point checkout.

3. Upon remote configuration, data to be auto-sent via encrypted https outbound data push back to cloud infrastructure.

4. Sight fully configured and portal access for CxP ready: 5 days after receipt of data.

5. First report: 15 days after portal is live.

6. First training session 15 days after portal is live.

7. Check-in meeting and training day 30 days after portal is live.

8. Check-in meeting and training day 60 days after portal is live.

9. Check-in meeting and training day 90 days after portal is live.

3.3 TREND SUBMISSION REQUIREMENTS

A. Prior to Site or Head-End controls commissioning, trends submission and approval are required. Water and air balancing shall be complete, and the Contractor shall have the software completely loaded and functional at least one week prior to the trends submission. Trends shall be submitted to the Engineer and the Commissioning Provider for review. The intent of this is to determine whether installed software is functioning as intended. Prior to submitting a trend, the Contractor shall perform a self review to identify and correct problems. Trends shall be presented at hourly intervals for a 24 hour period, unless directed otherwise. Trends cannot be submitted unless run for days when outdoor air temperatures have risen to at least 85°F or dropped to at least 35°F during the 24 hour trended period.
   1. Building trends shall be run with all systems being operated with an occupancy schedule; i.e. indications that a system was scheduled off for the 24 hours of the history and remained off are of no value.
   2. Trends submission shall include:
      a. Hardwired, virtual, BACnet, and LON control and monitoring points
      b. All system setpoints (both calculated and manual inputs). Floating setpoints (e.g. heating water reset; adjustable space temperatures) shall be trended hourly as done for all other points. Fixed setpoints may be trended or provided in a cover sheet statement (e.g. "All cabinet heaters have 70ºF space temperature setpoint.")
      c. All occupancy schedules shall be provided (e.g. Zone 1, 0600 – 1800). Overrides of occupancy scheduled shall be trended.
      d. Trends shall be submitted in printed form. Format shall provide an English language descriptor header for each point trended with 24 hourly samples printed in columns below the header. Points pertinent to the system trended shall be grouped on a single page when possible; e.g. all AHU control points should be printed on the same or contiguous pages.

B. EMS trends shall be submitted by the Contractor two times a year to the Owner for review. The submission of trends may be increased or decreased pursuant to their evaluation; i.e., decreased if all is well, increased if problems exist. Prior to submitting a trend to the Owner, the Contractor shall perform a self review to identify and correct problems. Heating mode trends shall be run when outdoor air temperatures have dropped to below 35°F during the trended period, outdoor air temperatures shall have risen above 85°F for cooling mode trends. The histories shall contain all of the points and be for the same time intervals cited hereinbefore for Punch-Out histories.

C. Deficiencies noted via trends will be documented for rectification. After notification that deficiencies have been rectified, trends will be re-run for verification. This process will be

repeated as necessary until trends indicate suitably appropriate operations to warrant site observation.

D. On-site control systems demonstrations shall not occur without the central plant operating in either the mechanical heating or cooling mode; if scheduled delivery of the project falls during a period in which the central plant is not operating, control system demonstration will be delayed until such time as the central plant has been operating under EMS control for the afore specified one week.

E. During on site observation, control systems will be exercised through full sequences pertinent to seasonal operation.

F. Initial acceptance of the EMS in either the heating or cooling mode shall be conditional, final acceptance shall be predicated on acceptance of the EMS in the subsequent seasonal operation; i.e. the EMS must function properly in both heating and cooling modes.

G. The following control and monitoring points shall be trended (in addition to those noted above for schedules, setpoints, etc.). This list will be up-dated based on the approved controls submittal and may include more points if the CxP determines they are necessary to properly diagnose system operations:

1. Global:
    a. Outdoor air temperature
    b. Outdoor air humidity
    c. All building electrical meters being monitored
        1) kW
        2) hourly kW
        3) Daily kW
        4) Weekly kW
        5) Monthly kW
        6) Annual kW
        7) Peak kW
2. Geothermal System:
    a. All pumps
        1) On/Off command
        2) Status
        3) Speed command
        4) Speed feedback
        5) VFD Fault alarm
        6) Run time
        7) Main/Standby
    b. All differential pressure readings
    c. All flow meter readings (GPM)
    d. All BTU meters:
        1) Meter current use
        2) Meter hourly use
        3) Meter daily use
        4) Meter Monthly use
    e. Fill line flow meter
        1) Current GPM

2) Fill line timer
3) Total GMP

f. All temperature sensors
g. All pump pressures
h. All valves
1) command
2) status

3. Water-to-Water Heat Pump System
a. All water temperatures
b. All Pumps:
1) Command
2) Status
3) Run time
4) Main/standby
c. 3-way valve position
d. 2-way head pressure valve position - BACnet
e. Heating/cooling mode - BACnet
f. Compressor status – BACnet
g. General alarm - BACnet

4. OA-1
a. Dual Temp modulating ECM pump:
1) Speed
2) Status
3) Command
b. Mode: Occupied/unoccupied/economizer/heating/cooling, etc.
c. All fans:
1) start/stop command
2) status
3) VFD speed command
4) VFD speed feedback
5) VFD Fault alarm
d. All Airflow monitors (CFM) and where applicable Sum of airflows.
e. All building static pressures
f. Duct static pressures
g. All temperature sensors
h. All humidity sensors
i. All dampers:
1) Command
2) Position
j. Filter status
k. Freezestat status
l. Smoke alarm status

5. VAVs:
a. Space temperature
b. Space occupancy
c. Airflow setpoint
d. Airflow actual
e. Damper position
f. CO2

6. Water Source Heat Pump

a. Space temperature
b. Setpoint offset
c. Pump command
d. Pump status
e. Water temperatures
f. Air temperatures
g. Fan command
h. Fan status
i. Compressor command
j. Compressor status
k. Heating/cooling mode
l. General alarm
m. Condensate alarm

7. Gym OA Control sequences:
   a. Event mode button status
   b. Event mode time
   c. VAV138A CFM
   d. VAV138B CFM
8. Exhaust fans:
   a. Status
   b. Command
   c. Interlocked VAV command or Exhaust fan command
   d. Wall switch command (Lab Hoods)
9. Air Pear:
   a. Start/stop
   b. Override
   c. Status
   d. OA Temperature
10. Kitchen Freezer/Cooler
    a. Pump start/stop command
    b. Pump status
    c. All temperatures
    d. 2-way valve command/position
    e. Flow switch status
11. Domestic Hot Water:
    a. Pump command
    b. Pump status
    c. All temperatures
    d. Aquatstat timer
12. Make-up-Water
    a. Flow
    b. Alarm
13. Electric heaters
    a. Command
    b. Status
    c. Space temperature
14. Split System AC
    a. Start/Stop command
    b. Space temperature
    c. Space temperature high alarm

3.4 FUNCTIONAL PERFORMANCE TESTING (FPT) PREPARATION

A. Start-up: Certify that HVAC systems, subsystems and equipment have been installed, calibrated and started and are operating according to the Contract Documents.

B. Testing, Adjusting, and Balancing: Perform testing, adjusting, and balancing of HVAC systems as indicated in individual Sections.

1. Provide technicians, instrumentation and tools to verify testing, adjusting, and balancing of HVAC systems.
2. Conduct pipe and duct leak testing and submit reports to CxP.
3. Certify that testing, adjusting and balancing procedures have been completed per the Contract Documents and that balancing reports have been submitted.

C. Participation: Coordinate schedule to ensure that all required members of the commissioning team as indicated in the functional performance testing (FPT) procedures are available to participate in FPT.

3.5 GENERAL FPT REQUIREMENTS

A. General: Test all normal and emergency modes of operations including alarms.

1. To greatest extent possible, use design conditions for test parameters, unless otherwise directed by Architect and CxP.
2. Simulated conditions may be imposed to initially test systems; however, this does not relieve the Contractor of his duty to perform deferred testing. Alter set points and sensor values when simulating conditions is not practical.

B. Common FPT Requirements: Functional performance tests shall demonstrate and verify that the following requirements, applicable to all HVAC systems, assemblies, equipment, components, and features indicated to be commissioned:

1. Verify functionality and compliance with the design intent for each individual sequence module in the sequences of operation. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Test every step in every written sequence and other significant modes, sequences and operational features not mentioned in written sequences; including startup, normal operation, shutdown, scheduled on and off, unoccupied and manual modes, safeties, alarms, over-rides, lockouts and power failure.
2. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.
3. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
4. Verify shut down and restart capabilities both for scheduled and unscheduled events (e.g. power failure recovery and normal scheduled start/stop).
5. When applicable, demonstrate a full cycle from off to on and no load to full load and then to no load and off.
6. Verify time of day schedules and setpoints.
7. Verify all energy saving control strategies.

8. Verify that monitoring system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
9. Verify operator control of all commandable control system points including proper security level access.

C. Common Acceptance Criteria: The following acceptance criteria apply to all HVAC systems, assemblies, equipment, components, and features indicated to be commissioned:

1. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications. Verify that equipment operates within tolerances specified in: governing codes, acceptance criteria contained in the construction documents, manufacturer's literature and according to good operating practice.
2. Systems shall accomplish their intended function and performance.
3. All safety trips shall require a manual reset to allow a system restart.
4. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.
5. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).
6. Other acceptance criteria are given in the equipment testing requirements articles or referenced standards.
7. Additional acceptance criteria developed by the CxP as part of FPT test procedures.

D. Penalty for Lack of Readiness: The CxP schedules testing once the completed Certificates have been signed off on and received. If the CxP finds that pre-checks have not been successfully completed and the systems are not ready for testing, back charges will be incurred by the Contractor. The Owner will impose financial penalties on the Contractor for unforeseen visits by the CxP pursuant to the General Conditions.

E. Re-Testing:

1. If tests indicate that system, assembly, equipment, or component does not meet acceptance criteria indicated, document the deficiency and report it to the Architect. Upon resolution of deficiencies, re-test using same original parameters unless otherwise directed by Architect and CxP. Notify Architect and CxP a minimum of five days of re-test date of rescheduled tests.
2. Deficiencies which prevent the verification of system performance may be uncovered during tests. In cases where the issue cannot be resolved within a reasonable amount of time, document the deficiency and report it to the Architect. Upon resolution of deficiencies, re-test using same original parameters unless otherwise directed by Architect and CxP. Notify Architect and CxP a minimum of five days before re-test date of rescheduled tests.

F. Deferred Tests:

1. Seasonal Testing: Provide deferred testing of the following systems to ensure that functional performance testing has been performed during seasons affecting operation of the system, equipment, assembly, or component:

a. Air Handling Units: Provide opposite season testing support.
b. Heating System Plant: Provide opposite season testing support.

2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Architect and CxP at least seven days in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Architect, CxP, and Architect/Engineer (AE). Schedule deferred tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

G. Monitoring Based Commissioning:

1. Submit at a minimum 12 reports during the first year software subscription, and provide the CxP full remote access to the software. Provide owner the option to take over the subscription at the end of the 1 year subscription.

3.6 HVAC FPT PROCEDURES

A. Air Handling Units:

1. Procedures:

a. Confirm interlocks for each mode.
b. Simulate a power outage and ensure orderly restart.

2. Modes:

a. Off/Standby.
b. Morning Warm-Up/Cool-Down Mode (optimized or scheduled start).
c. Occupied Mode.
d. Night Set-Back/Set-Up Mode.
e. Economizer Control.
f. Supply/Return Fan Control.
g. Discharge Air Temperature Reset.
h. Freeze Protection.
i. Minimum/Maximum Outside Air Modulation.
j. Demand Control Ventilation.
k. Alarms and Safeties.

3.7 NEAR END-OF-WARRANTY REVIEW

A. General: Participate in the Near End-of-Warranty review and walkthrough conducted by CxP.
1. The review will cover current building operation with input from the operation and facility staff. Outstanding issues related to the construction, particularly those related to the Owner's Project Requirements (OPR), and warranty related deficiencies will be addressed. Operational problems and concerns from the facility staff and occupants will be reviewed for compliance with design intent.
2. The CxP, in consultation with the Architect/Engineer (AE), will provide recommendation for improvements and corrective measures to the Architect and the Contractor for action.

B. Corrective Action: Where deficiencies and problems result from work not in compliance with the Contract Documents or where corrective actions are covered under warranty, provide the corrective action at no additional cost to Architect.

END OF SECTION 23 08 00

SECTION 23 11 00 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the other trades the required locations of sleeves. Improperly located openings shall be reworked at the expense of the Contractor.

   C. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go through; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at is own expense.

   D. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

   E. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.

   F. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

2. SLEEVES, PLATES AND ESCUTCHEONS

   A. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for pipes where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the pipe or conduit and the sleeves shall be made completely and permanently water tight.

   B. Pipe that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

C. At all other locations either pipe sleeves or core drilled openings are acceptable.

D. Where thermal expansion does not occur, the wall may be sealed tight to the pipe or insulation.

E. Insulation, that requires a vapor barrier (i.e., cold water or refrigerant piping, etc.), must be continuous through the sleeve/cored hole. For other piping, insulation may stop on either side of the sleeve.

F. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" above finished floor level.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

H. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.

I. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

3. CUTTING

A. All rectangular or special shaped openings in plaster, stucco or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.

B. Contractors shall coordinate all openings in new and existing masonry walls with the General Contractor; and, unless otherwise indicated on the Architectural drawings, provide lintels for all openings required for the work (Louvers, wall boxes, exhaust fans, etc.). Lintels shall be sized per Structural Engineers requirements.

C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

4. PATCHING AND REPAIRING

A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.

C. Where the installation of conduit, ducts, piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

D. Where ducts penetrate fire rated assemblies, fire dampers shall be provided with an appropriate access door.

E. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.

F. Stainless steel collars shall be provided around all ducts, large pipes, etc., at all wall penetrations; both sides.

G. Where ducts, pipes, and conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to insure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

H. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

END OF SECTION

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SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. 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 14 inches as indicated on the drawings.

1.3 SUBMITTALS

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

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Field quality-control reports.

E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

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

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

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
5. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
   a. OmegaFlex, Inc.
   b. Parker Hannifin Corporation; Parflex Division.
   c. Titeflex.
   d. Tru-Flex Metal Hose Corp.
6. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
7. Coating: PE with flame retardant.
   a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   b. Flame-Spread Index: 25 or less.
      1) Smoke-Developed Index: 50 or less.
8. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
9. Striker Plates: Steel, designed to protect tubing from penetrations.
10. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
11. Operating-Pressure Rating: 5 psig.

B. 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.

2.2 PIPING SPECIALTIES

A. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor applications.
   5. Adjustable, retractable restraining cable.

B. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller.
   3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for 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.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. 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. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal.
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
   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, 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. Valve Boxes:
1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
a. ASCO Power Technologies, LP; Division of Emerson.
b. Dungs, Karl, Inc.
c. Eclipse Combustion, Inc.
d. Goyen Valve Corp.; Tyco Environmental Systems.
e. Magnatrol Valve Corporation.
f. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
a. Actaris.
b. American Meter Company.
c. Eclipse Combustion, Inc.
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys.
f. Maxitrol Company.

g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 2 psig

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
a. Eaton Corporation; Controls Div.
b. Harper Wyman Co.
c. Maxitrol Company.
d. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig .

2.7 DIELECTRIC UNIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
1. Capitol Manufacturing Company.
2. Central Plastics Company.
3. Hart Industries International, Inc.
4. McDonald, A. Y. Mfg. Co.
5. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
6. Wilkins; Zurn Plumbing Products Group.
7. Minimum Operating-Pressure Rating: 150 psig.

B. Combination fitting of copper alloy and ferrous materials.

C. Insulating materials suitable for natural gas.

D. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.8 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.9 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
   2. Advance Products & Systems, Inc.
      a. Calpico Inc.
      b. Metraflex Company (The).
      c. Pipeline Seal and Insulator, Inc.
   3. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
   4. Pressure Plates: Carbon steel.
   5. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.10 LABELING AND IDENTIFYING

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

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
   1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:
1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

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

F. Exterior-Wall Pipe 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.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 22 Section "Meters and Gages."

3.2 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code 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. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. 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.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. 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.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 22 Section "Meters and Gages."

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 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.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports."

B. 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: Maximum span, 120 inches; minimum rod size, 3/8 inch
5. NPS 3 and Larger: Maximum span, 144 inches; minimum rod size, 3/8 inch

3.6 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance of appliances.

B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Exterior gas piping on roof shall be primed and painted yellow in accordance with architectural painting specifications prior to labeling.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

B. Distribution piping valves shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

C. Valves in branch piping for single appliance shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

END OF SECTION

SECTION 23 12 00 – HYDRONIC EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall include all excavating, filling, grading, and related items required to complete his work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.

   C. Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2-0" to the side. Electric and fuel lines shall always be placed in a separate trench. All exterior lines shall have a minimum earth cover of thirty (30) inches to top of pipe, unless otherwise indicated.

   D. Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be encased for a distance not less than 5 feet on either side of the point of crossover.

2. SUBSURFACE DATA

   A. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavating to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating. This paragraph is written to include the removal of all rock with no extras, whether rock is indicated or not.

3. BENCH MARKS AND MONUMENTS

   A. Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

   A. Excavate trenches of sufficient width for proper installation of the work. When the depth of backfill over sewer pipe exceeds 10 feet, keep the trench at the level of the top of the pipe as narrow as practicable. Trench excavation for piping eight inches and smaller shall not exceed thirty inch width for exterior lines and twenty-four inch width for interior lines.

B. Sheet and brace trenches as necessary to protect workmen and adjacent structures. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc., and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.

C. Rules and regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities discovered in the course of excavation shall be protected or relocated in accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineers. Machine excavation shall not be allowed within ten (10) feet of existing electric lines or lines carrying combustible materials. Use only hand tools.

D. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Engineer. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the Contractor's expense.

E. Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to insure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell, or flange and/or is supported with blocks or wedges will not be accepted.

F. Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper jointing of pipe. Any water pumping from this Contractor's trenches which is required during construction, shall be included in this Contract.

G. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, large trees to remain, etc. The Contractors shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be borne by the responsible Contractor.

H. Use surveyor's level to establish elevations and grades.

I. The Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation of his work.

J. The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all

traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.

K. Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Mechanical Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

5. BACKFILL AND SURFACE REPAIR

A. Backfilling for mechanical work shall include all trenches, manhole pits, storage tank pits, and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.

B. Unless otherwise indicated or specified, all piping shall be bedded on four (4) inches minimum of compacted naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve on undisturbed soil excavated as described hereinbefore. Install tracer wire above pipe. Cover the pipe with twelve (12) inches of compacted backfill to prevent settlement above and around the new pipe. The backfill shall be naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. Prior to placing this second level of backfill, apply all required coatings and coverings to pipe, apply required tests and check the grading of the pipe to insure that it is correct and that the pipe is free of swags, bows or bends. Also check lines for leaks at this point and repair as required. Once all of the preceding is accomplished, continue backfill with clean, debris and rock free earth tamped at six (6) inch intervals. Finish the backfill as specified following. Note: Water settling of backfill will be permitted only as an aid to mechanical compacting.

C. Backfill beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.

D. Backfill beneath paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill or unstable soil. Once the backfill is installed as stated above for piping, refer to 312300 for requirements.

E. Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.

F. Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.

G. Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.

H. In the absence (if not specified or indicated elsewhere in the drawings or specifications to be done by others) of such work by others, the Contractor shall lay new sod over his excavation work. Level, compress and water in accord with sound sodding practice.

I. When running any type of piping below a footer or in the zone of influence the piping shall be backfilled with cementitious flowable fill. The zone of influence is the area under the footer within a 45 degree angle projecting down from the bottom edge of the footer on all sides of the footer. Additionally, grease traps, manholes, vaults, and other underground structures shall be held away from building walls far enough to be outside of the zone of influence.

J. Warning Tape and Tracer Wire

Provide a yellow and black plastic tape in all trenches 6" above the buried utility that identifies the utility about to be encountered. For non-metallic pipe a #12 copper wire shall also be laid in the trench to aid in future location of the piping. A foil faced warning tape may be used in lieu of the plastic tape and wire.

K. All manholes, vaults, and similar underground structures shall have the top elevation set flush with finished grade unless specifically noted otherwise.

6. MINIMUM DEPTHS OF BURY (TO TOP OF PIPE)

In the absence of other indication, the following shall be the minimum depth of bury of exterior utility lines. (Check drawings for variations).

A. Geothermal Lines .....42 inches.

END OF SECTION

SECTION 23 13 00 –MECHANICAL PIPE, PIPE FITTINGS AND PIPE SUPPORT

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineers. All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

C. All pipe shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted. Spacing of pipe supports shall not exceed eight feet for pipes up to 1-1/4 inches and ten feet on all other piping. Small vertical pipes (1 inch and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. (Refer to Specifications Section entitled INSULATION-MECHANICAL). In metal buildings, support piping with standard pipe hangers with C-clamp connection to main structural members (not perlins), use angle steel cross pieces between main structural members where required to provide rigid support.

D. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation.

E. In general, piping shall be installed concealed except in Mechanical, Janitor Rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur they shall be kept as close to walls as possible.

F. Installation of pipe shall be in such a manner as to provide complete drainage of the system toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be 1/2" size gate type with 3/4" hose thread end and vacuum breaker. Label each drain valve.

G. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing; if in doubt, consult Engineer.

H. Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and sound practice.

I. Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineers.

J. Nipples shall be of the same material, composition and weight classification as pipe with which installed.

K. Apply approved pipe dope (for service intended) to all male threaded joints. Pay particular attention to dope for fuel gas lines. The dope shall be listed for such use.

L. High points of closed loop hot water heating systems shall have manual or automatic air vents as indicated or required unless automatic air vents are specifically indicated. Pipe to suitable drainage point.

M. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.

N. Provide expansion joints where shown on the plans and where required by good practice. Expansion joints shall be guided and anchored in accordance with the recommendations of the Expansion Joint Manufacturer's Association.

O. Where plastic pipe penetrates a fire rated assembly, it shall be replaced with a metal threaded adapter and a metal pipe per code.

P. Where piping penetrates interior or exterior walls, the wall shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

Q. All piping to hydronic coils shall be full size all the way to the coil connection on the unit. If control valve is smaller than pipe size indicated, transition immediately before and after control valve. Also, if coil connection at unit is a different size than the branch pipe size indicated, provide transition at coil connection to unit. On 3-way valve applications, the coil bypass pipe shall be full size.

2. UNIONS AND FLANGES AND WELDED TEES

A. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. Gaskets for steam piping systems shall be flexitalic spiral wound type. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

B. Dielectric insulating unions or couplings shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.

C. Tee connections for welded pipe shall be made up with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller.

3. SPECIFICATIONS STANDARDS

All piping and material shall be new, made in the United States and shall conform to the following minimum applicable standards:

A. Steel pipe; ASTM A-120, A-53 Grade A, A-53 Grade B.

B. Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.

C. Cast iron screwed fittings; ASA B16.4.

D. Welding fittings; ASA B16.9.

E. Cast brass and wrought copper fittings; ASA B16.18.

F. Cast brass drainage fittings; ASA B16.23.

G. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.

4. PITCH OF PIPING

All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

A. Condensate Drain Lines From Cooling Equipment:

Not less than 1/4 inch per foot in direction of flow.

B. All Other Lines:

Provide ample pitch to a low point to allow 100 percent drainage of the system.

5. APPLICATIONS

A. General Notes

(1) Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.

(2) Plastic piping or any materials with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.

B. Hydronic Piping (Hot, Chilled, Dual Temperature to OA Unit)

(1) 2" and Smaller: Schedule 40 black steel pipe with screwed fittings or Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

(2) 2-1/2" and Larger: Schedule 40 black steel pipe with 125# welded or flanged joints. Weldolets may be used for branch line connections to pipe mains. Type "L" hard copper piping with wrought copper fittings and 95/5 solder may be installed.

(3) Schedule 40 Victaulic or approved equivalent mechanical grooved pipe couplings and fittings with 125# rating minimum may be used. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 220°F water temperature. Mechanical grooved piping may not be used if system water temperature exceeds 220°F.

(4) Special Notes:

a. Dielectric unions shall be provided at all connections of dissimilar materials.

b. Copper and steel piping shall not be mixed in the mechanical room.

c. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.

d. Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

C. Air Vent Discharge Lines

Type "L" soft copper; wrought copper fittings, 95/5 solder.

D. Refrigerant Piping

ACR copper tubing with forged or wrought copper fittings and silver soldered joints. Solder must have a minimum of 15% silver content.

(1) General Installation Notes:

a. Contact Engineer 24 hours prior to installation of refrigerant lines or evacuation of refrigerant system.

b. Refrigerant lines installation must meet HVAC equipment manufacturer's recommendations.

c. While installing or soldering refrigerant lines, system must continuously be purged with nitrogen.

d. After system is installed, the refrigerant system must be evacuated to 25 microns for eight hours.

E. Condensate Drain Lines

(1) Type "DWV" copper, wrought copper, lead free solder.

F. Geothermal Interior Piping(GS, GR and HPS, HPR)

a. Mains and branches – Piping shall be virgin polyethylene with a PE 3408 piping formaulation and 345464C or greater cell classification. Pipe shall be SDR 15.5, minimum pressure rating of 110 psi at 73.4°F.

b. Branches - Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

c. Transitions from polyethylene to copper – refer to detail on drawings. **Factory manufactured transition required** with brass threads. No metal threads shall be inserted into polyethylene piping, and no polyethylene threads shall be inserted into metal piping.

d. The only acceptable method for joining pipe is by a heat fusion process. Pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures. Installers shall have heat fusion school certification per geothermal specifications. Provide copy of heat fusion card to Engineer for review.

e. Within the main pump room, Schedule 40 Victaulic or approved equivalent mechanical grooved pipe couplings and fittings with 125# rating minimum may be used. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 220°F water temperature. Mechanical grooved piping may not be used if system water temperature exceeds 220°F.

f. Special Notes:

1) Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

(2) Special Notes:

a. Copper and steel piping shall not be mixed in the mechanical room.

b. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.

c. Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

G. Geothermal / Heat pump loop piping (Exterior)

a. HDPE. Refer to separate specification section 201320.

H. Hydronic Fill Lines

a. For fill lines fed by the plumbing system, piping shall be same as specified for the domestic water piping until it connects to the hydronic system.

END OF SECTION

SECTION 23 13 20 - GEOTHERMAL (EARTH COUPLED) LOOP PIPING SYSTEM

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. INSTALLATION PERSONNEL AND TRAINING REQUIRED

   A. The loop installer, must have a current International Ground Source Heat Pump Association (IGSHPA) certification, having completed an IGSHPA training course in the fundamentals of design, installation, and operation of ground source systems, and having passed the IGSHPA certification examination.

   B. Ground heat exchanger fabricators must have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of a IGSHPA Certified Heat Fusion Technician. The Fusion Technician must be thoroughly familiar with heat fusion procedures, and have had formal training at a heat fusion school under direct supervision of an IGSHPA certified instructor.

   C. Local and state laws, ordinances, and regulations as they pertain to buried pipe systems shall be strictly followed.

3. GROUND HEAT EXCHANGER MATERIALS - GS/GR OUTSIDE BUILDING ENVELOPE

   A. Piping shall be virgin polyethylene with a PE 4710 piping formulation and cell classification of 445576C or E per ASTM D 3350. Pressure ratings are at 73.4° F.

   B. 2" and smaller shall be SDR 9. Pressure rating of 255 PSI.

   C. 3" and larger shall be SDR 15.5 or Schedule 40. Pressure rating of 135 PSI.

   D. Markings

      (1) Sufficient information shall be permanently marked on the length of the pipe as defined by the appropriate ASTM pipe standard.

      (2) Piping shall also have permanent factory length markings.

   E. Certification

      (1) Manufacturer shall supply a notarized document confirming compliance with the above standards.

   F. Manufacturers

(1) Centennial Plastics, Charter Plastics, Flying W Plastics, Lamson Vylon Plastics, Chevron Phillips, or Polypipe.

G. Warranty

(1) Manufacturer shall supply a written warranty of 25 years or greater, specifying material replacement and labor allowance. This applies to all pipe, fittings, transitions, valves, etc.

4. PIPE JOINING METHODS

A. The only acceptable method for joining buried pipe systems is by a heat fusion process.

B. Polyethylene pipe shall be butt or socket fused in accordance with pipe manufacturer's procedures.

C. Factory installed "U" bends shall be used at the bottom well bend.

5. CASING

A. Casing shall be steel. PVC casing is not acceptable.

B. The Contractor shall include in the bid an allowance for 20 feet of permanent left-in-place steel casing per each new geothermal well indicated on the drawings. Provide a unit price per linear foot of additional casing. The actual amount of casing used per hole shall be tracked with a casing log and wellfield schematic. Schematic shall depict geothermal wells and provide labels for each. Log shall state the bore hole number (as depicted on the schematic), date and time casing was installed, and linear feet of casing left in place for **each** bore hole. For example:

Bore hole # 1	8/1/09	2 P.M.	30 feet of casing installed
Bore hole # 2	8/2/09	9 A.M.	10 feet of casing installed

This log shall be kept current at all times and be **signed daily during drilling** by the well field installer, mechanical contractor, General Contractor and Owner’s representative.

C. Contractor shall submit a unit price for steel casing left in place on the Bid Form.

D. The casing log and the submitted casing unit price will be used to reconcile the Contract Amount with the actual amount of casing installed. The Contractor will only be paid the full unit price for casing left in place. Push and pull casing (temporary casing) will be paid at half the rate for casing left in place.

6. FLUSHING, PURGING, PRESSURE AND FLOW TESTING

A. General

(1) Coordinate this section with the cleaning and flushing listed in Section 234200 - HVAC Equipment.

(2) All fusion joints and loop lengths shall be checked to verify that no leaks have occurred due to fusion joining or shipping damage.

B. Pressure Testing

(1) Vertical loops shall be pressure tested before installation. All horizontal components of the ground heat exchanger will be flushed, pressure and flow tested prior to backfilling. Pipes must contain fluid under pressure during backfilling.

(2) Heat exchangers shall be tested hydrostatically at 150% of the pipe design rating or 300% of the system operating pressure if this value is the smaller of the two. No leaks shall occur within a 48 hour period. Engineer shall be notified when system is to be placed under pressure test.

C. Flushing and Purging

(1) Notify the Engineer a minimum of 2 weeks in advance of system flushing. The Engineer, Mechanical Contractor, Heat Pump Supplier, Test and Balance Contractor, and Well Field Installer shall all be present to observe system flushing and purging. Schedule the system flushing to occur the same day as a regularly scheduled progress meeting. The Engineer MUST BE PRESENT. Failure to notify the Engineer in advance will result in the Contractor having to flush the system a second time.

(2) Flow rates shall be compared to calculated values to assure that there is no blockage or kinking of any pipe. Submit this in writing to the Engineer. Balance Contractor to verify.

(3) A minimum velocity of 3 ft/sec in each piping section must be maintained until all air is removed. Piping 8” and larger shall be purged at 4 ft/s minimum. The system shall also be forward and reverse flushed to remove all debris. The building shall be flushed in sections as required to maintain high velocities. Building mains shall be flushed separate from branches to maintain high velocity when flushing the mains.

(4) Final purging of air from the entire building and loop field shall be performed by the Well Field Installer so that air in building piping will not be transferred to the well field.

(5) The Balance Contractor must witness and confirm all pressure tests and flushing velocities along with confirm pressure drop for each geothermal well zone.

(6) Contractor shall provide full size connection ports and valves as required to purge wellfield and building separately.

(7) After the heat pump bypasses are flushed and the piping network is determined to be clean and free of air, the heat pumps themselves shall be flushed.

(8) The system flushing device shall be equal to a Purge Pro Max distributed by Geothermal Supply Company. The flushing pump shall provide performance equal to or exceeding the following values: 550 GPM at 117 PSI, dead head pressure of 128 PSI. SUBMIT PUMP CURVE to Engineer for review and approval prior to system flush. The flushing device shall provide means to release entrained air to the atmosphere and shall filter the water. Filter

shall be 50 micron. Water shall be circulated and filters shall be changed until debris is no longer visible on filter. Contractor shall provide filter media as required.

(9) The Geothermal Piping System consists of two (2) loops required separate flushing. Building loop shall be flushed and geothermal loop shall be flushed. Two loops are separated and valves provided at primary secondary header (PSH-1).

D. Regulatory Requirements

(1) Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.

(2) Perform field testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and as specified.

(3) Installation shall comply with COMAR, EPA, MDE regulations, as well as the authorities having jurisdiction.

7. HORIZONTAL PIPING SYSTEMS

A. Sharp bending of pipe around trench and bore hole corners must be prevented by using a shovel to round corners. Manufacturer's procedures must be followed.

B. Backfilling procedure will include prevention of any sharp-edged rocks from coming into contact with the pipe by removal of the rocks before backfilling, backfilling through a coarse screen for a 6 inch cover, or use of a 6 inch cover of rock-free soil. Clods resulting from use of a backhoe must be broken up so as not to form air pockets around the pipe which will reduce heat conduction between the earth and the pipe. The flow of backfill soil must be controlled to prevent bridging and the formation of air pockets. Several slow passes with an angled backfill blade are required. Flooding is required to assure removal or air pockets. Since most of the horizontal piping is below the parking lot, the backfill shall support the expected bus traffic. Backfill load bearing capacity shall meet the Architect's specification.

C. Provide a plan of the entire geothermal well field with coordinates for each borehole identified, as located on the site plans by a Maryland Licensed Professional Land Surveyor. The coordinates shall be in the same datum as the site plan.

D. Horizontal return bends must be backfilled by hand to properly support the pipes and prevent kinking.

E. All horizontal piping shall be a minimum of 60 inches below finished grade where routing under other utilities and must be carefully coordinated with other disciplines and utilities. It is the geothermal well drillers responsibility to coordinate all site items with the entire set of contract documents. Where geothermal is not in conflict with other utilities the height may be modified to 48 inches below grade. Additionally where required for coordination the geothermal piping height may be modified upon coordination with design engineer.

8. BORE HOLE

A. The Contractor shall bore wells of a sufficient diameter to allow installation of the piping and U-bend, but shall be no less than 4-1/2".

B. The entire bore shall be grouted as recommended by IGSHPA with a thermally enhanced grout mixture with a thermal conductivity of 1.00 Btu/hr-ft-˚F. Grout shall be GeoPro Thermal Grout Lite 100 bentonite mixture or approved equal. Mixture shall be field mixed in strict accordance with manufacturer's recommendations. Grout mixture shall be mechanically pumped with a positive displacement pump into bore hole from bottom to top utilizing a tremie tube. Through the course of the project, three sample grout specimens shall be taken of the mixed grouting material by this contractor. An analysis shall be performed by the grout manufacturer to verify proper thermal performance and grout mixture. This contractor shall submit these reports to the Owner, Architect and Engineer to verify compliance with the installation specifications.

C. If large water seams are encountered, bridging across water seams with #7 or #9 rock, or GeoPro Black Hills 3/8 inch Bentonite Plug, is acceptable. The maximum height of the rock or bentonite bridge shall not exceed 8 feet. The remainder of the vertical bore hole shall be grouted per the above specification. Bore holes with water seams shall be monitored for settling of grout. After a period of one week, all holes shall be topped off with grout as needed. The Contractor shall continue to monitor holes that experience grout settling and continue to top off with grout throughout the warranty period. Bore holes that are unable to hold grout shall be replaced with new bore holes at no cost.

D. The Contractor shall accept the site as-is and is responsible for any and all required casings. If an area of voids is encountered, the Contractor shall either fill or re-drill wells in an approved area and extend piping to them.

E. No night drilling will be allowed.

F. Provide a plan of the entire geothermal well field with coordinates for each borehole identified, as located on the site plans by a Maryland Licensed Professional Land Surveyor. The coordinates shall be in the same datum as the site plan.

9. DUST CONTROL

A. The Contractor is responsible for and shall provide dust control. Dust shall not be allowed to leave the construction site boundaries, and furthermore, shall not be allowed to enter the building or accumulate on the building exterior. When needed to meet these requirements, the Contractor shall provide and operate a mechanical dust collection system to control dust at the source. Mechanical dust collection system shall consist of collection hood at the source ducted to a dust collector which separates dust from the airstream. Dust shall be collected into sealed containers for disposal by the Contractor.

B. Water spraying may be used but shall not be considered a substitute for mechanical dust collection at the source when required.

10. SURFACE WATER / MUD / SLURRY CONTROL

A. The Contractor is responsible for and shall provide control of all ground flowing fluids resulting from drilling operations. The Contractor shall erect silt fences or other structures as required to contain drill cuttings, mud, slurry, etc. within the construction site boundaries. In the event this

requirement is not met, the Contractor shall provide all remediation measures as required by all authorities having jurisdiction over such events.

11. SITE WORK

A. The Geothermal Contractor shall be responsible for the design and installation of all sediment and erosion controls needed for the earth and heat exchanger installation. Provide temporary swales, stone/rip-rap, straw dikes, retention basins, silt fence, super silt fence, etc., above and beyond what is provided on the approved Sediment Control Plans in accordance with MDE Sediment Control requirements. The Geothermal Contractor shall coordinate all work with other trades, including the Site/Utility Contractor, Electrical Contractor, Mechanical Contractor and Construction Manager. A pre-installation conference shall be held with the Owner, Construction Manager, Architect/Engineer, Site Utility Contractor, Mechanical Contractor, DPIE Inspector(s), Health Department Inspector, and/or MDE Sediment Control Inspector prior to starting any geothermal installation. The Geothermal Contractor shall provide a plan and contractor designed/submitted/approved permit documents, if required, of temporary sediment and erosion controls anticipated based on varying water yield conditions, quantity of drilling rigs, installation sequences, etc. Temporary sediment erosion controls for the installation of the earth heat exchanger shall minimize impact on the site and other trades, while maintaining all environmental requirements of the Authorities Having Jurisdiction.

12. WARRANTY

A. The entire ground loop system and backfill from a point 5 feet inside the building shall be warranted for **five (5) years** from date of substantial completion against any leakage or failure. Warranty service for a pipe leak shall include recharging system with heat transfer fluid as originally specified, including glycol or ethyl alcohol if originally specified, as well as corrosion inhibitors.

13. BALANCE

The Contractor shall assist the Balance Contractor in balancing the geothermal well zones to obtain the specified flows.

14. SUBMITTALS

A. Submit manufacturer's specification sheets and installation instruction for each component of the system, showing manufacturer, pipe or tube weight, pressure rating, fitting type and joint type for each piping system.

B. Submit manufacturer's mechanical data for valves.

C. Submit a drawing indicating the system layout and pipe sizes.

D. Provide a copy of the technician's certification, and International Ground Source Heat Pump Association Certification.

15. TEST BORES

A. Test bore report is provided at the end of this spec section. Please refer to Geothermal Test Well Report.

B. The Contractor may visit the site prior to bid and perform their own test boring if additional information is required. This shall be coordinated with the Owner.

END OF SECTION

Geothermal Test Well Report

GLENRIDGE MIDDLE SCHOOL

HYATTSVILLE, MD

Prepared for:

Geotech Engineering, Inc.
11890 Old Baltimore Pike, #U
Beltsville, MD 20705

Prepared by:

GeoPotential Consulting LLC
43676 Trade Center Place, Suite 235
Sterling, Virginia 20166

GPC Project Number GPC GT1902
May 13, 2019

May 13, 2019

Geotech Engineering, Inc.
11890 Old Baltimore Pike, #U
Beltsville, MD 20705

Attention: Mr. Brett Sweeney (Allied Well Drilling, Client Representative)

Re: Geothermal Test Well Report
Glenridge Middle School
5211 Flintridge Dr
Hyattsville, MD 20784
GPC Project No.: GPC GT1902

Dear Mr. Sweeney:

GeoPotential Consulting, LLC (GPC) has completed the geothermal test well engineering services for the above-referenced Glenridge Middle School project. These services were performed in general accordance with our contract with Allied Well Drilling and information provided by Allied Well Drilling.

This report presents the geothermal (ground source) test well results for project design and construction. The test well was drilled to 400 ft below existing grades and a 1 ¼ HDPE SDR-11 geothermal loop was installed and grouted with a bentonite grout mix of 0.4 Btu/hr-ft-degF (information provided by Allied Well Drilling). Groundwater was not reported during drilling and installation of the geothermal loop. However, groundwater is anticipated within 100 ft below existing grades, based on hydrogeologic data for this region.

To obtain the thermal properties of the subsurface soils and rock, the American Society of heating, Refrigeration, and Air-conditioning Engineers (2011 ASHRAE Handbook HVAC Applications, Chapter 34) recommended guidelines for performing formation thermal conductivity tests for geothermal applications was utilized for this project.

The thermal conductivity is a measure of the capacity of the soils and rock to conduct heat. A higher soil conductivity allows heat to be exchanged within the soils/rock faster for a configuration of the ground loop. The diffusivity of the system defines the heat flow rate.

After a setting period, the Formation Thermal Conductivity tests were performed at each well by IGSHPA and NATE Certified Geothermal Professionals. A GeoCube thermal conductivity tester was used to perform the thermal conductivity tests.

A snapshot of the tests performed is as follows:

Description	Method of Performance
Test Duration	Actual tests were conducted for 48+ hours
Power Quality	The standard deviation of the power was less than 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power
Heat flux rate per foot of borehole depth	15 Watts to 25 Watts (maintained approx. 19.9 Watts)
Undisturbed Formation Temperature Measurement	Measured during the first ten minutes of the test, prior to the interference of pump heat input
Installation Procedures for Test Loops	Borehole diameter of 5.25” with bore annulus uniformly grouted from the bottom to the top utilizing a tremie pipe to avoid bridging and voids.
Time Between Loop Installation and Testing	>5 days
Test Well Flow Rate (GPM)	8.57 GPM
Grout Thermal Conductivity	0.4 Btu/hr-ft-degF

During the test, water is heated at a uniform rate and circulated through the ground loop. Heat is rejected (heat of rejection) to the ground to simulate full cooling load operations. The water temperatures to and from the loop, water flow rate, and electrical power consumption (equal to heating rate) are measured and recorded prior to heating and throughout the test duration. The results are presented in Appendix A. Please note that the Temperature vs Time chart depicts the increase in temperature from start of test, at the EWT and LWT within the loop.

The thermal diffusivity is calculated by the ratio of the computed formation thermal conductivity and the estimated heat capacity. The Borehole Thermal Resistivity calculated from the test data was 0.14 hr.ft.°F/btu.

The formation thermal conductivity, the undisturbed formation temperature, and the BTR provides the thermal performance of the test wells for conditions approximating the test conditions. Based on this test well, the recommended BTR for loop field sizing is given below:

Recommended Average BTR: 0.14 ft.°F.hr/btu

We suggest that GPC be retained to review the final design plans and specifications, so comments can be made regarding interpretation and implementation of our test well results in the design and specifications. We suggest that GPC's qualified, experienced and certified professionals be retained to provide observation and testing services during installation of the geothermal production wells.

The analysis and recommendations presented in this report are based upon the data obtained from the drillers and laboratory tests performed by others at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between drilling, across the site. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified, so that further evaluation and supplemental recommendations can be provided.

The scope of services for this report does not include either specifically or by implication any environmental or biological assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and prepared in accordance with generally accepted engineering practices. No warranties, either express or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless GPC reviews the changes and either verifies or modifies the conclusions of this report in writing.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions concerning this report, or if we may be of further service.

Sincerely,
GPC

Muthu Arigovindan, P.E., LEED AP BD+C, CGD, CGI
President

APPENDIX A
FIELD TEST RESULTS

GEOPOTENTIAL CONSULTING

RECORD OF TEST WELL EXPLORATION

Prc: Glenridge MS — Test Well Number PG-11-0119

Loc: 5211 Flintridge Drive, Hyattsville, MD — Project # GPC GT1902

Dat	N/A	Driller	Orli	Completed Depth (ft.)	400
Apprx. Surface Elev.(ft)	148.0	Logged by	M.Arigovindan	Cave-in	N/A
Date Started	4/17/2019	Completed	4/17/2019	Grouted	4/17/2019
Bore Diameter (in.)	5.25	Bore Diameter for casing (in.)	None	Grouted Depth (ft.)	400
Depth of Water (ft.)	N/A	Casing Installed	None (Mud Rotary)	Casing Type	None (Mud Rotary)
Water Bearing Zones (ft.)	N/A	Casing Diameter (in.)	None (Mud Rotary)	Cased Depth (ft.)	None (Mud Rotary)
LOOP Nominal Diameter (in.)	1-1/4	Dimension Ratio	DR-11	Actual Assembly Length (ft.)	N/A
Grout Manufacturer:	N/A	Product:	N/A		
Grout Mixture: Bentonite (lb):	800.00	Grout-Water Ratio:	2:1	Sand (lb)	N/A

ELEV.	SOIL/ROCK DESCRIPTION	STRA. DEPTH	DEPTH SCALE (ft)	EXCAVATION AND FIELD ACTIVITY NOTES
148	SURFACE		0.0	No.
	Topsoil Clay			
	GRAVEL Clayey SAND			Lat: 38.931033 Long: -76.8963742
	White and red, Clayey GRAVEL			
98			50	
	Gray, CLAY, Hard			
	SAND, with wood Rock			Hard Drilling
	Red, CLAY Clayey SAND Red, CLAY			
48			100	
	Clayey SAND GRAVEL White and grey, CLAY			
-2			150	
	SAND Red, CLAY Rock			Hard Drilling
-52			200	
-102	Red, Clayey SAND		250	
	Red, Sandy CLAY			
-152			300	
	Gray, Sandy CLAY			
	Sandy CLAY			
-202			400	
	Test Well terminated at 400 ft.			- Loop installed on 4/17/2019.

Ground Loop Design

Thermal Conductivity Report - 5/13/2019

Project Name:	**Glenridge Middle School**		
Project Address:	5211 Flintridge Road		
City:	Hyattsville	**State:** MD	**Zip:** 20784
Prepared By:	Muthu Arigovindan, PE, LEED AP BD+C, CGD, AI		
Email:	MArigovi@geopotentialllc.com	**Phone:**	(571)237-4345
Drill Date	4/17/2019		
TC Test Date(s)	5/1/2019	>>	5/3/2019
Client Name:	**Geotech Engineering, Inc.**		
Address Line 1:	11890 Old Baltimore Pike, #U		
Address Line 2:			
City:	Beltsville	**Phone:**	301-937-9227
State:	MD	**Fax:**	
Zip:	20705	**Email:**	DillonFurbay@geotechengineeringinc.com

Calculation Results

Thermal Conductivity (Btu/(h*ft*°F)) :	**1.15**
Thermal Diffusivity (est.) (ft^2/day) :	**1.02**
Average Heat Flux (W/ft) :	**19.9**
BH Thermal Resist (BTR) (h*ft*°F/Btu) :	**0.14**
Average Flow Rate (gpm) :	**8.57**
Test Duration (hr) :	**36**
Calculation Interval :	**1.0 - 37.0 Hours**

Borehole Input Parameters

Undisturbed Ground Temperature (°F) :	**59.6**	(Auto-Estimated)
Depth (ft) :	**400**	
Borehole Diameter (in) :	**5.25**	
Pipe Size:	**1 in. (25 mm)**	
Grout Thermal Conductivity (Btu/(h*ft*°F)) :	**0.40**	
Drilling Method :	**Standard**	
Drilling Time (hr) :	**15.0**	

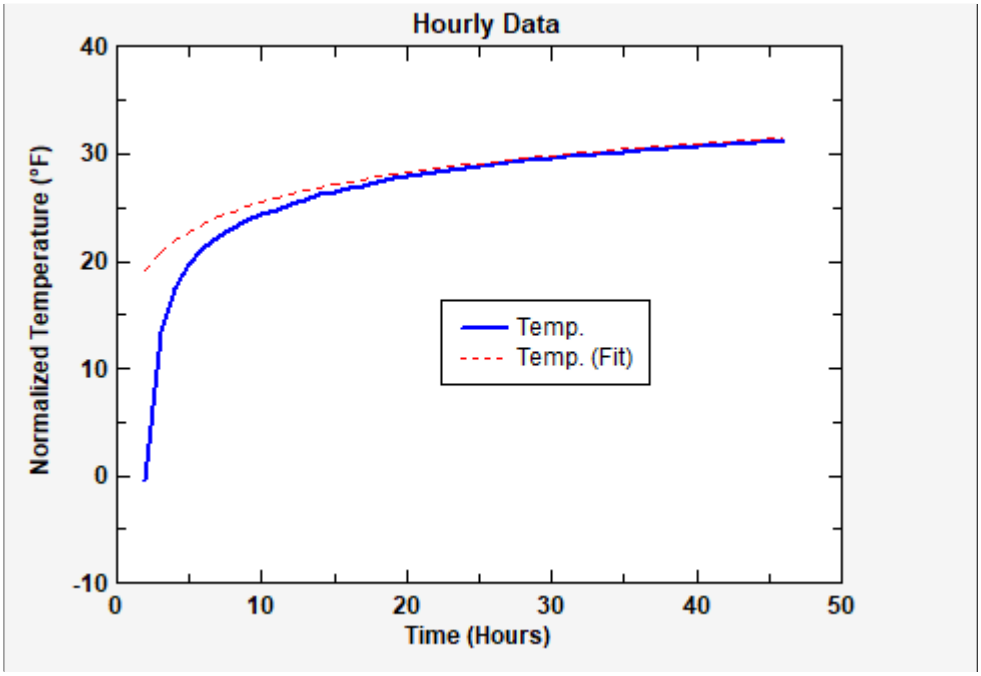
Diffusivity Input Parameters

Soil/Rock Specific Heat - Dry (Btu/(°F*lbm)) :	**0.200**
Soil/Rock Density - Dry (lb/ft^3) :	**100.0**
Moisture (0-100) (%) :	**10.0**

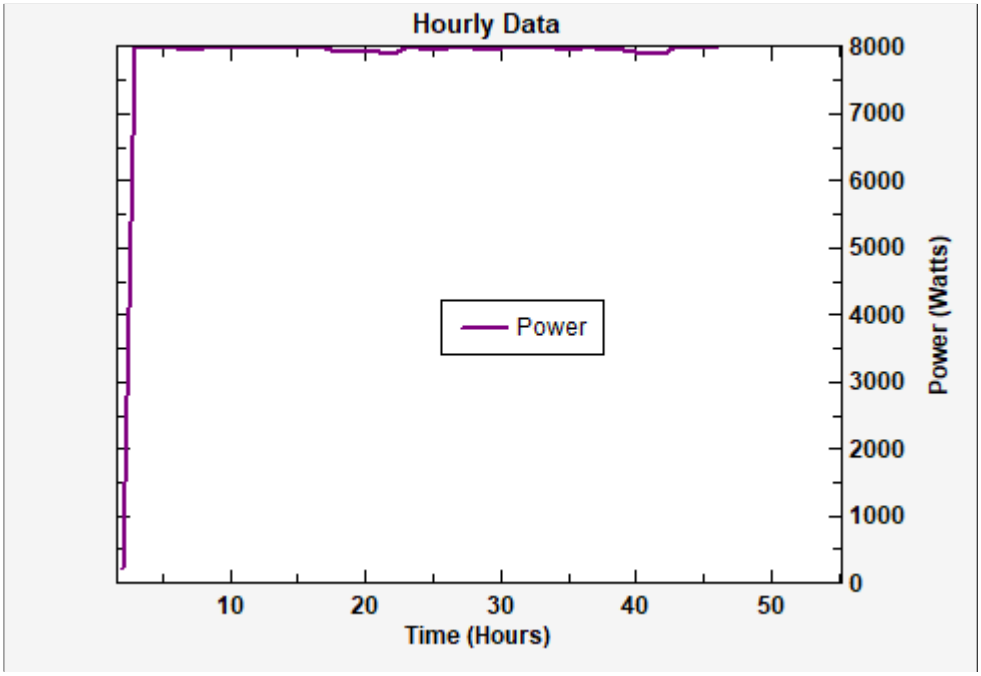
Flow Rate Input Parameters

TC Unit Model Name	**GeoCube Standard**

Temperature vs Time

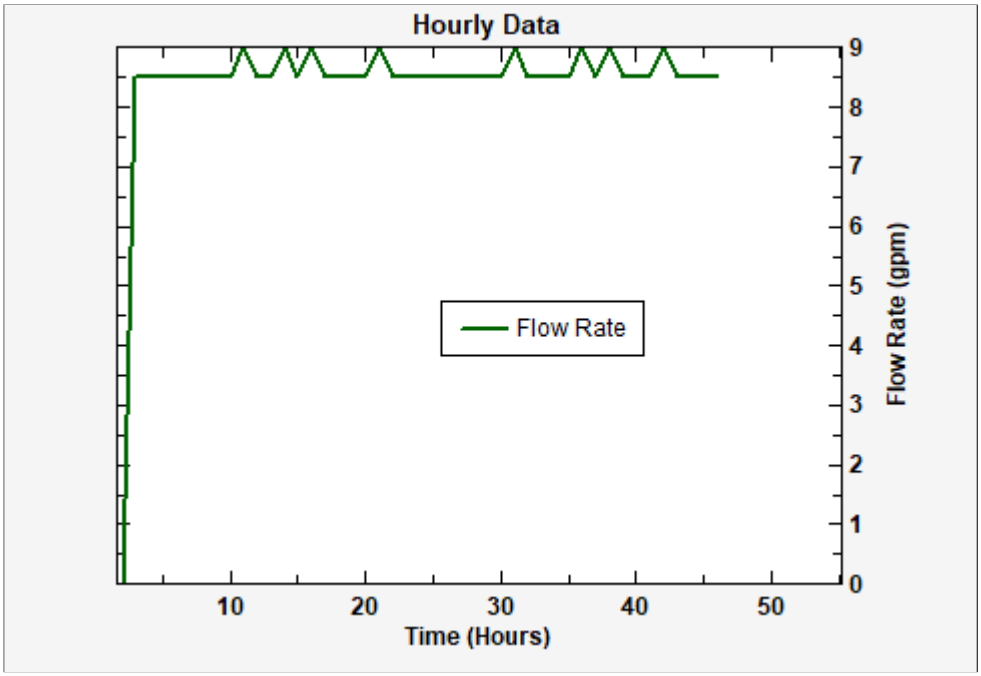


Power vs Time



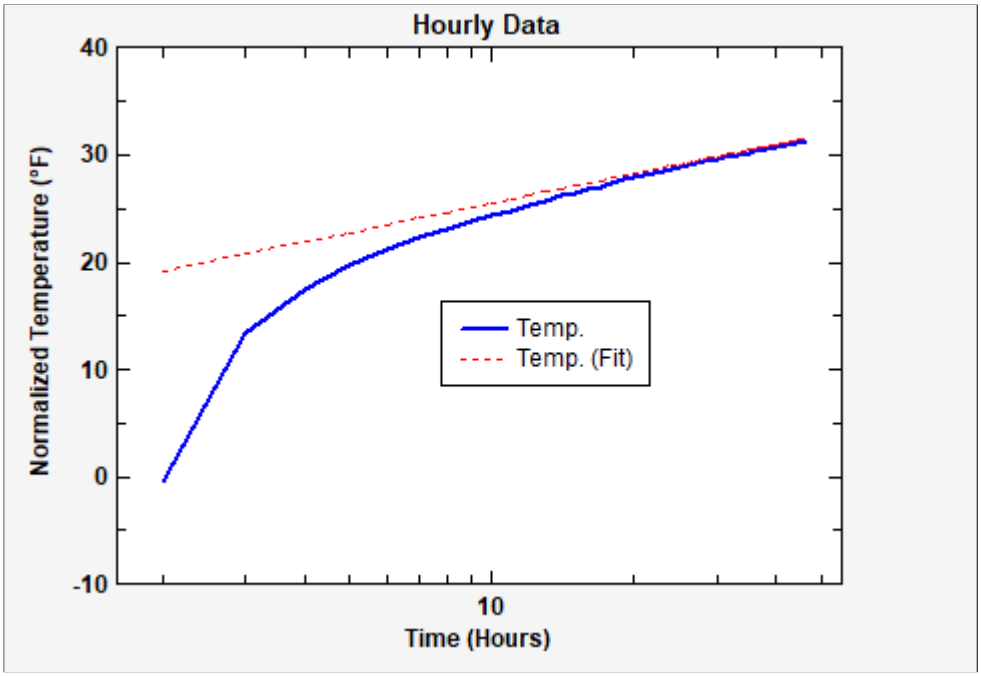
Average Power 7973.9 Watts

Flow Rate vs Time



Average Flow Rate 8.57

Temperature vs ln(Time)



Slope :	**4.71**
Calculation Interval :	**1.0 - 37.0 Hours**

Data Quality

		Threshold			Threshold
Power Standard Deviation :	**Pass**	**1.50 %**	Flow Rate :	**Pass**	**5.00 %**
Power Variation :	**Pass**	**10.00 %**	Slope Stability :	**Pass**	**25.00 %**
Temperature :	**Pass**	**5.00 %**	Water Flow Test :	**Pass**	**20.00 %**

Comments

TW-1

SECTION 23 21 00 – MECHANICAL VALVES AND COCKS

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing cocks, air cocks, lubricated plug cocks, packed plug cocks, special valves for special systems, etc., for all Mechanical Systems.

C. All valves shall be designed and rated for the service to which they are applied.

D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.

E. Ball valves with temperature and pressure ports are not an acceptable alternative to the balancing valves specified herein. Valves that do not comply with these specifications shall be removed and replaced by the Contractor with no increase in contract price.

F. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts.

G. All valves shall comply with current Federal, State and Local Codes.

H. All valves shall be new and of first quality.

I. All valves shall be full line size. Valves and hydronic specialties shall not be reduced to coil or equipment connection size. Size reductions shall be made at the connection to the equipment.

J. All valves for use in potable water systems shall comply with federal lead free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. LOCATION OF MAINTENANCE VALVES

Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

A. At each air handling unit, and make–up air unit.

B. At each heat pump.

C. At each heating or cooling coil.

D. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to insure tightness against leakage for service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.

4. TYPES AND APPLICATION

A. GATE VALVES

Gate Valves shall be of the wedge disc type, permit straight line flow, complete shut-off and designed so that when the valve is wide open, it can be packed under pressure. Valves 1-1/2 inches and smaller shall be bronze, with ends to suit piping and non-rising stem. The valve shall have a deep stuffing box for long contact with the stem, packing gland and filled with high quality packing. Valves 2 inches thru 4 inches shall be iron body bronze mounted with flanged ends and non-rising stem. Boiler stop valves and valves larger than 4 inches shall be iron body bronze mounted flanged ends with outside screw and yoke with rising stem. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 2" and under NIBCO T133, greater than 2" NIBCO F619. All gate valves 2” and smaller for use in potable water systems shall meet federal requirement to be lead free containing less than 0.25% lead by weight of wetted area. NIBCO F768B.

B. GLOBE VALVES

Globe Valves shall permit control of flow rate from full flow to complete shut-off and designed that when the valve is wide open it can be repacked under pressure, and have a deep stuffing box with gland and filled with high quality packing. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping union bonnet, and with stainless steel plug type disc and seat of not less than 500 Brinnell hardness. Valves 2 inches and larger shall be iron body bronze mounted with flanged ends, yoke bonnet, and disc guide. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 1-1/2" and under NIBCO T256AP, greater than 1-1/2" NIBCO F768B.

C. CHECK VALVES

Check Valves shall be horizontal swing type with two piece hinges, disc construction seats to be bronze and bronze discs or with composition face depending on service and provide silent

operation. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping, have full area "Y" pattern body and integral seats. Valves 2 inches and larger shall be iron body brass mounted and with flanged ends. Working pressure for bronze valves shall be 150 psi and iron valves 125 psi when installed in piping with system pressures up to 100 psi and 250 psi for 100 psi and over. 3" and under NIBCO T433Y, greater than 3" NIBCO F918B (for less than 100 psi systems) greater than 3" NIBCO F968B (for 100 psi or greater systems).

D. BALL VALVES (NON-POTABLE)

Ball Valves shall have removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blow out proof stem, bronze body, reinforced Teflon seats, chrome plated steel ball as manufactured by Consolidated Valve Industries, Inc., Lunkenheimer, Apollo, Jenkins, Nibco or equivalent. Provide a stem extension so that the base of the handle is 1/4" above the insulation. NIBCO T5800-70.

E. BALL VALVES (POTABLE WATER)

All valves for use in potable water systems 2" and smaller contain less than 0.25% lead by weight and comply with federal lead free potable water requirements. Ball valves shall have a removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing boxring, blowout proof stem, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Appollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that they bas of the handle is ¼" above the insulation. NIBCO S-585-66-LF.

F. BUTTERFLY VALVES

Butterfly valves shall be line sized cast iron body, lug style, 200 PSI rating (bubble tight) EPT or Viton seat, cartridge type; high strength stem. Disc to have ground and polished seating surface. Operator shall be locking lever style. Quality equivalent to Crane Monarch series. 3" and under NIBCO LD3222-3, greater than 3" NIBCO LD322-5.

G. BALANCING VALVES

Bell & Gossett, Model CB circuit setter balancing valve or approved equivalent. Calibrated balancing valve shall have flanged connections suitable for 125# working pressure at 250°F. 4" and up shall be rated at 175# at 250°F working pressure. Provide with brass readout valves fitted with an integral EPT insert and check valve. Each balance valve shall have a calibrated nameplate to assure specific valve settings and be constructed with internal seals to prevent leakage. **Note: Refer to Specification Section 234200-HVAC Equipment for automatic flow control balancing valves on terminal equipment.**

H. AIR COCKS

Straight nose; Lunkenheimer Fig. 476; bronze; tee handle; bent nose; Lunkenheimer Fig. 478, 125#; bronze; tee handle.

I. GAUGE COCKS

Straight, Lunkenheimer, Fig. 1178; 125#; bronze; tee handle. FIP.

J. LUBRICATED PLUG COCKS

2" and under; Homestead Fig. 601; 150#; semi-steel; screwed; 2-1/2" and over; Homestead Fig. 602; ±50#; semi-steel; flanged.

K. PACKED PLUG COCKS

2" and under; DeZurik Fig. 425-S; 175#; semi-steel; screwed. 2-1/2" and over; DeZurik Fig. 425-F; 175#; semi-steel; flanged.

END OF SECTION

SECTION 23 21 10 - ACCESS TO VALVES, EQUIPMENT, FILTERS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. All mechanical equipment shall be installed in a manner which allows ready access to all components requiring service, adjustments, shutoff, etc.

   C. Filters shall be accessible, removable and replaceable without disconnecting mounting brackets, piping, wiring, etc.

   D. Provide access doors or panels for all equipment, valves, dampers, filters, fire dampers, etc. in concealed spaces not otherwise provided with suitable access. (Lay-in ceilings shall be considered acceptable access; splined or drywall ceilings shall not).

   E. All valves, unions, strainers, cleanouts, volume dampers, and test points shall be accessible.

   F. Access panels in lay-in ceilings shall be labeled with a lamacoid plate to indicate location of equipment, filters, valves, etc.

   G. Access panels in fire rated walls shall bear the same rating as the wall.

   H. Each fire damper shall be provided access through the duct to allow reset of the damper. This may be either a gasketed sheet metal panel over a suitable opening or a factory built access panel. The panel shall be at least one and one-half (1½) inch larger than the opening all around and shall be held in place with sheet metal screws sufficiently to insure that it is air tight. Manually check the size and location of each of these openings to insure that the fire damper may be manually reset by use of hand only.

2. ACCESS DOORS

   Refer to Sheet Metal and Flexible Duct section of the specifications.

END OF SECTION

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SECTION 23 22 00 - INSULATION - MECHANICAL

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.

   C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

   A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or other approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

   A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.

   B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.

   C. All products and their packaging shall bear a label indicating above requirements are not exceeded.

   D. Duct linings shall meet the Erosion Test Method in compliance with UL Publication No. 181.

4. GENERAL APPLICATION REQUIREMENTS

   A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.

   B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork is to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used.

No noticeable deformation of insulation or discontinuity of vaporseal, where required, will be accepted.

C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.

E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!

F. All insulation shall be installed with joints butted firmly together.

G. The Contractor shall insure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

5. PIPING SYSTEMS

A. GENERAL

(1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.

(2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to ensure no condensation drip or collection.

(3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.

(4) Valves, flanges and unions shall be insulated where the piping is insulated.

(5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

(1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180 degree arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket approved manufacturers are listed in section 2. Manufacturers. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers' recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

(1) Hydronic System Fill Lines From Domestic Cold Water - 1/2" thick.

(2) Dual Temperature (Hot-Chilled) or Chilled Hydronic Water

Owens Corning Vapor Wick Insulation System including wicking pipe wrap and cellular glass pipe insulation and jacket.

Install in strict accordance with manufacturer's recommendations:

a. Piping 1 ½'' or less – use 1 ½'' thick insulation.

b. Piping 2" or larger – use 2" thick insulation

(3) Condensate Drain Lines.

a. Piping 1 ½'' or less – use 1/2" thick insulation

b. Piping 2'' or greater – use 1'' thick insulation

(4) Geothermal Interior Piping (GS, GR and HPS, HPR)

a. HDPE piping mains – use 1/2" thick insulation
b. Copper branch piping- use 1/2" thick insulation

(5) Refrigerant Liquid and Suction Lines - Interior & Exterior

IMCOA, Nomaco, or Armacell closed cell polyethylene, 1.5 Lbs/Ft^3 density, 0.24 BTU-Hr.-Ft^3-°F/in at 75°F thermal conductivity, zero vapor permeance, 25/50 flame and smoke spread per NFPA 90 requirements. Elastomeric closed cell insulations that meet the above requirements are also allowed. Install insulation per the manufacturer's requirements. Provide UV protective coating for all exterior refrigerant lines.

a. All pipe sizes: 1 ½'' thick

D. JACKETS

(1) Exposed (Mechanical Rooms, Interior Finished Rooms and Storage Rooms)

All insulated piping installed in the above areas shall have a canvas or PVC jacket:

a. 6 oz. canvas jacket with fire retardant lagging. Apply to the insulation specified for the piping. In Heat pump closets, the canvas jacket shall only be installed up to 7' above finished floor. In the main pump room where the geothermal piping enters and exits the building, all exposed piping shall be canvas wrapped.

b. For all systems except steam, plenum rated PVC jacket equal to LoSmoke PVC jacket with flame/smoke rating of 25/50, ASTM-E84 test method. Minimum thickness 0.04 inches. Steam systems shall utilize plenum rated CPVC jacket with minimum thickness of 0.04 inches. Jackets shall be applied over top of specified pipe insulation. Approved equal manufacturers are Zeston and Speedline. Approved equal manufacturers are Zeston and Speedline.

(2) Exposed (Exterior) – Outdoor Refrigerant Piping

In addition to the insulation specified for the exterior pipe, provide .016" aluminum jacket or PVC jacket 0.05" thick. The jackets shall be installed as recommended by the manufacturer to maintain water tight seal. All longitudinal and transverse seams to be sealed water tight. PVC jacket shall be Ceel-Co, Proto, or Zeston.

6. DUCTWORK SYSTEMS

A. GENERAL

(1) Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.

(2) Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to insure no condensation drip or collection. The backs of all supply diffusers, plenums, grilles, etc. shall be insulated only if indicated by details on the drawings.

(3) All flexible duct connections on insulated ductwork shall be externally insulated.

(4) All duct outside of building envelope, including rooftop duct, duct in unconditioned attic spaces above the insulation, etc. shall have two layers of specified insulation. This shall

apply to supply air, exhaust air where air is run through energy recovery unit, outside air, return air, and combustion air intake ducts.

B. EXTERNAL INSULATION
(1) Supply Air
(2) Outside Air From OA-1 to Intake Louver
(3) Exhaust Air From OA-1 to Exhaust Louver

Owens/Corning “Faced Duct Wrap - Type 100", or approved equal, 2" thick fiberglass duct wrap, **1.0 pcf** density factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch. K factor shall not exceed .26 at 75°F. mean temperature. Minimum R-value of the 2” thick insulation shall be 7.4 out of package and 6.0 installed.

C. INTERNAL INSULATION (ACCOUSTICAL)

(1) Return Air on Heat Pumps return for 15 feet from the filter towards the grille
(2) Supply Air on Heat Pumps from discharge of heat pump 15 linear feet from heat pump discharge.

Duct liner shall be 1 ½’’ thick Armacell Coilflex duct liner or equalwith factory-applied edge coating or approved equivalent. The liner shall meet NFPA 90A and 90B, FHC 25/50 and Limited Combustibility and the airstream surface coating should contain an immobilized, EPA-registered, anti-microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22, UL 181. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than .60 as tested per ASTM C 423 using a Type "A" mounting, and a thermal conductivity no higher than .25 mean temperature. Minimum R-value of the 1 ½’’ thick insulation shall be 6.0. All exposed edges shall be sealed with edge treatment products in accordance with the manufacturer's recommendations. The duct size listed on the plans where internal insulation is used shall be the free area of the airstream.

7. MECHANICAL EQUIPMENT

A. EXPANSION TANK, COMPRESSION TANK, AIR SEPARATOR, SIDESTREAM/LOOP FILTERS, AND WATER STORAGE TANKS FOR DUAL TEMPERATURE LOOP

(1) Owens-Corning "Tank Wrap I" or approved equivalent. Insulation shall be constructed of non-combustible, flexible wool. Insulation shall be 2" thick. K factor shall be .29 at 100°F. mean temperature. Insulation shall be attached in strict accordance with the manufacturer’s recommendations. All insulation shall be jacketed with 6 oz. canvas with fire retardant lagging. Coordinate with mechanical contractor to extend all piping connections, blowdown ports, etc. outside of the insulation. Additionally for loop filters and other equipment requiring periodic service, provide removable insulated covers.

END OF SECTION

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SECTION 23 23 00 - THERMOMETERS & OTHERS, MONITORING INSTRUMENTS

1. GENERAL

   A. The Contractor shall include all thermometers, pressure gauges and/or compound gauges at the locations indicated.

2. THERMOMETERS AND PRESSURE GAUGES

   A. All thermometers and gauges shall be readable from a standing position on the floor.

   B. Thermometers shall be linear, alcohol filled, graduated in 1°F. Or less and shall have adequate range for service intended.

   C. Pressure gauges shall be Bourdon Type, circular, 3" face, black letters on white face graduated in 2 PSI or less and shall have adequate range and shall be manufactured for service intended. Provide with pig tail connectors and gauge cocks.

   D. Pressure gauges and thermometers subject to vibration shall be mounted remotely away from vibrating pipe surface, etc., with flexible tubing.

   E. Mount thermometers in approved wells and install with thermal grease. Do not make direct contact of base with fluid in pipe.

   F. Gauges and thermometers shall be Marsh, Marshalltown, Weksler or equivalent.

3. Provide, when indicated on the plans, on the inlet and outlet of each terminal unit, a “Pete’s Plug” or equivalent pressure/temperature test station. Furnish two (2) matching thermometers and pressure gauges to the owner upon project completion.

END OF SECTION

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SECTION 23 24 00 – IDENTIFICATIONS, TAGS, CHARTS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. VALVE TAGS AND CHARTS

   A. Provide and install on each valve in the Mechanical Systems a 1-1/2" diameter circular brass tag fitted to each valve so that it cannot be removed. Each tag shall be embossed consecutively with letter and number identifiers as to system and purpose respectively. Letter identifiers shall be as follows:

DTS/DTA	Dual Temperature
HPS/HPR	Heat Pump Supply/Return
GS/GP	Geothermal Supply/Return
RF	Refrigerant

   Number identifiers shall be determined by the Contractor sequentially. For example, valve No. HC-1 may be maintenance stops for fan coil units. HC-2 maintenance stops for air heaters, etc.

   B. Provide three (3) copies of typewritten valve charts indicating each valve identifier, the valves purpose and its location. For example: "HC-1 Fan Coil Maintenance Stop-one valve at supply and return of each fan coil unit." One (1) copy of this chart shall be mounted in suitable wood frame(s) with clear plastic or glass covers in a conspicuous location in the Mechanical Room. Two other copies shall be turned over to the Engineers.

   C. Where more than one major Mechanical room is indicated for the project, install mounted valve schedule in each major Mechanical Room, and repeat only main valves which are to be operated in conjunction with operations of more than single Mechanical Room.

3. PIPING IDENTIFICATION

   A. GENERAL

      (1) All exposed piping installed shall be identified according to the color coding chart hereinafter specified. In addition, provide stenciled markers and arrows indicating direction of flow on all piping installed under this Contract after the piping has been painted. Markers and arrows shall be painted on the piping using machine cut stencils. All letters shall be sprayed using fast drying lacquer paint. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor. At the Contractor's option, Setmark or equivalent manufactured marking system may be substituted for field marking. The

following table describes the size of the color field and size of the identification letter which shall be used for pipes of different outside pipe diameters.

OUTSIDE DIAMETER OF PIPE OR COVERING	LENGTH OF COLOR FIELD	SIZE OF LETTERS
INCHES	INCHES	INCHES
3/4 TO 1-1/4	8	1/2
1-1/2 TO 2	8	3/4
2-1/2 TO 6	12	1-1/4
8 TO 10	24	2-1/2
OVER 10	32	3-1/2

(2) "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

B. PAINTING (REFER ALSO TO ARCHITECTURAL SECTION ON PAINTING)

(1) Paint exposed pipe (whether insulated or bare) where located in finished spaces.

C. All piping shall be marked. Piping shall be marked not less than every 15 linear feet above a ceiling system, every 10 feet in a mechanical room, and at all points where the piping passes through wall or floors.

D. Piping, whether exposed or concealed, shall be marked not less than every 15 linear feet and at the points where the piping passes through wall or floors.

4. EQUIPMENT IDENTIFICATION

A. All equipment, except in finished rooms, shall be identified by stenciling the title of the equipment as taken from the plans in a position that is clearly visible from the floor. The letters shall be made with black paint and shall be not less than two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. Lamacoid plates are also acceptable. In finished rooms or outdoors, equipment shall be identified by engraved nameplates.

5. DUCTWORK IDENTIFICATION

A. All ductwork shall be identified as to the service of the duct and direction of flow. The letters shall be at least two inches high and the flow arrow shall be at least six inches long. The letters and flow arrow shall be made by precut stencils and black oil base paint with aerosol can. Concealed ducts need not be identified.

6. ACCESS THROUGH LAY-IN CEILINGS

A. Mark the ceiling T-bar nearest the ceiling panel access to equipment, valves, damper, filter, duct heaters, etc., with a small red lamacoid plate with name of item above ceiling.

END OF SECTION

SECTION 23 25 00 – MECHANICAL HANGERS, CLAMPS, ATTACHMENTS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. Each Contractor's attention is also directed to Section 23 13 00, Pipe, Pipe Fittings and Pipe Support.

   C. This section includes, but is not limited to, furnishing and installing dampers, supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work.

   D. Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

2. MATERIALS AND EQUIPMENT

   A. Hangers, Clamps, Attachments, Etc.:

	SIZE	SPECIFICATION
1. Pipe Rings	2" pipe and smaller	Adjustable swivel split ring or split pipe ring, Grinnell Figures 104 and 108, Elcen, Fee & Mason, or approved equivalent.
2. Pipe Clevis	2-1/2" pipe and larger	Adjustable wrought Clevis type, Grinnell Figure 260, Elcen, Fee & Mason, or approved equivalent.
3. Pipe Clevis	All	Steel Clevis for insulated pipe, Elcen Figure 12A, Grinnell, Fee & Mason or approved equivalent.
4. Rise Clamps	All	Extension pipe or riser clamp, Grinnell Figure 261, Elcen, Fee & Mason or approved equivalent.
5. Beam Clamps and Attachments	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason, or approved equivalent. Malleable beam clamp with extension piece figure 229; I-beam clamp figure 131; C-clamp figures 83, 84, 85, 86, 87, and 88.

6. Brackets	All	Welded steel brackets medium weight, Grinnell Figure 195, Elcen, Fee & Mason or approved equivalent.
7. Concrete Inserts	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason or approved equivalent. Wrought steel insert Figure 280 and wedge type insert Figure 281.
8. Concrete Fasteners	All	Self-drilling concrete inserts, Phillips, Grinnell, Elcen or approved equivalent.
9. Ceiling	All	Grinnel Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Pipe hanger flange Figure 153, adjustable swinging hanger flange Figure 155, ceiling flanges Figures 128 and 128R, and adjustable ceiling flange Figure 116.
10. Rod Attachments	All	Grinnel Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Extension piece Figure 157, rod coupling Figure 136, and forged steel turnbuckle Figure 230.
11. U-Bolts	All	Standard, U-bolt, Grinnell Figure 137, Elcen, Fee & Mason, or approved equivalent.
12. Welded Pipe Saddles	All	Pipe covering protection saddle sized for thickness of insulation, Grinnell Figure 186, Elcen, Fee & Mason or approved equivalent.
13. Pipe Roll	All	Adjustable swivel pipe roll, Grinnell Figure 174, Elcen, Fee & Mason, or approved equivalent.
14. Protection Saddle	All	18 gauge sheet metal pipe protection saddle, Elcen Figure 219, Fee & Mason, Power Strut, or approved equivalent.
15. Hanger Rods	All	Steel, diameter of the hanger threading, ASTM A-107.

16. Miscellaneous Steel	All	Steel angles, rods, bars, channels, etc., used in framing for supports and fabricated brackets, anchors, etc., shall conform to ASTM-A-7.
17. Concrete Channel Inserts	All	Continuous slot inserts, Unistrut, or approved equivalent. Heavy duty Series P-3200 or Light Duty Series P-3300 as required.
18. Adjustable Spot Insert	All	Adjustable spot insert Unistrut, or approved equivalent, P-3245. Design load 1000 lbs.

3. INSTALLATION

A. Unless otherwise specifically indicated or hereinafter specified in the specifications, all supporting, hanging and anchoring of piping, ductwork, equipment, etc., shall be done by each trade as is necessary for completion of the work and shall be as directed in the following paragraphs:

(1) Supporting and hanging shall be done so that excessive load will not be placed on any one hangers so as to allow for proper pitch and expansion of piping. Hangers and supports shall be placed as near as possible to joints, turns and branches.

(2) For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power driven devices may be used when approved in writing by the Architect/Engineer. Utilize beam clamps for fastening to steel joists and beams and expansion anchors in masonry construction. When piping is run in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger.

(3) Trapeze hangers shall be supported by steel rods of sufficient diameter to support piping from joists or concrete construction. Where desired or required, piping may be double mounted on trapeze hangers. Where conditions permit, trapeze hangers may be surface mounted on exposed joists by means of approved beam clamps, or to concrete construction by means of approved adjustable inserts or expansion anchors.

(4) Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross steel joists.

(5) Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.

(6) Where piping, etc., is run vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum and an approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.

(7) Where piping is run along walls, knee braced angle frames or pipe brackets with saddles, clamps, and rollers (where required) mounted on structural brackets fastened to walls or columns shall be used.

(8) Support all ceiling hung equipment, with approved vibration isolators.

(9) Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.

(10) Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze and wall bracket type support shall be held in place with U-bolts. U-bolts shall allow for axial movement in the piping.

(11) All insulated piping shall be supported with clevis type and/or pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.

(12) Under no conditions will perforated band iron or steel wire driven hangers be permitted.

(13) In general, support piping at the following spacing:

a. Steel and copper piping - 5 feet intervals for piping 3/4" and smaller. 6 feet intervals for 1 ¼” and 1” pipe. 8 foot intervals for piping 1 ½” to 3". 10 foot intervals piping 3 ½” and larger.

b. Polyethylene piping – 4 foot intervals for piping 2” and smaller. 5 foot intervals for 3” pipe. 6 foot intervals for 4”, 6”, and 8” pipe. 7 foot intervals for 10” and larger pipe.

c. Where the manufacturer of the pipe has more strict guidelines, the manufacturer’s recommendations shall be followed.

END OF SECTION

SECTION 23 31 00 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

1. GENERAL

   A. The General Conditions, Instructions to Bidders, Section 23 01 00, and other Contract Documents are a part of this specification and shall be binding on all Mechanical Contractors. It shall be each Contractor's responsibility to apprize himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.

   B. The Engineer, or his authorized representative, shall be notified by the Contractor one (1) week in advance of any tests called for in these specifications or required by others. The Engineer will determine which of these test they will witness. Any leaks or imperfections found shall be corrected and a new tests run to the satisfaction of the Engineer or his authorized representative. Upon completion of a test, a written approval of that part of the work will be given to the Contractor. Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow his work to be furred-in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

2. HYDRONICS

   A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

   B. Water piping systems shall be subjected to a hydrostatic test of one hundred fifty pounds. The systems shall be proven tight after a twenty-four (24) hour test.

   C. Thermometers and gauges shall be checked for accuracy. If instruments prove defective, they shall be replaced.

   D. The Contractor shall perform all additional tests that may be required by the Maryland Department of Health or other governing agency.

   E. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.

3. HEATING, VENTILATING AND AIR CONDITIONING

   A. The test and balance of this system shall be by a contractor who employs only the services of a certified AABC or independent NEBB firm whose sole business is to perform test and balance services. The test and balance contractor shall report all deficiencies to the engineer.

   B. The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic

test of not less than one hundred pounds and shall be proven tight after a twenty-four (24) hour test.

C. All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating and control valves shall be adjusted. Excessive noise or vibration shall be eliminated. Provide all start-up documents to Designer prior to any test and balance services.

D. System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.

E. All fan belts shall be adjusted for proper operation of fans.

F. All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.

G. For the purpose of placing the heating, ventilating and air conditioning system in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council. The following systems shall be test and balance:

(1) The exhaust and outside air duct systems associated with OA-1. Provide static pressure profiles thru each system. Static pressure profiles shall include all sections from the outside air duct inlet and outside air outlet and exhaust air outlet and exhaust air inlet of the air handling unit. On units equipped with exhaust air fans; show location and profile of the exhaust fan.

(2) The geothermal (GS/GR) pumps.

(3) The dual temperature (DTS/DTA) pumps.

(4) Set the minimum and maximum air flow rates for each VAV and CAV box.

(5) Balance all supply, return and exhaust air grille to within 10% of design air flow rate.

(6) Balance the kitchen rangehood supply/exhaust air system.

(7) All circulator pumps serving water-source heat exchangers. Refer to drawings for location of all distributive pumping circulators.

(8) Pressure test ductwork if required by sheet metal specification section 234400.

(9) Adjust all adjustable diffusers to minimize air drafts and eliminate suspended light fixture sway. Furthermore, adjustable diffusers in spaces with ceilings taller than 9 feet shall be adjusted to eliminate air stratification during heating season.

H. Provide a preliminary test report to the mechanical engineer immediately after the system is air balanced, or any initial phases are balanced. This report may be hand written. Anticipate visiting the site again after the engineer has reviewed the report. The engineer may request up to 15

additional static pressure measurements for any air handling system to help resolve any balancing deficiencies. Include five additional static pressure measurements for each exhaust air system.

I. The Test and Balance agency shall provide lifts, scaffolding, etc. as required to balance devices in areas with high ceilings such as gymnasiums, auditoriums, atriums, cupolas, etc. The Test and Balance agency may coordinate with the General Contractor or Mechanical Contractor to arrange for these items to be provided to access high devices, however, it is emphasized the Contractor is finally responsible for providing the means required to balance all devices.

J. Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.

K. Test and Balance agency is to provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor will purchase and install all sheaves and belts as required. This includes new and existing equipment.

L. An electronic copy of the complete test reports shall be submitted to the Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.

M. The Contractor shall provide and coordinate their work in the following manner:

(1) Provide sufficient time before final completion date so that tests and balancing can be accomplished.

(2) Provide immediate labor and tools to make corrections when required without undue delay.

N. The Contractor shall put all heating, ventilating and air conditioning systems and equipment and rangehood system into full operation and shall continue the operation of same during each working day of testing and balancing.

O. Geothermal Balance

(1) Confirm flushing velocities (forward and backward) in geothermal well field.

(2) Confirm pressure drop values for each well field zone.

(3) Set flow rate for each well field zone.

(4) Submit report confirming above geothermal information to the Engineer prior to submission of final balance report.

P. Automatic Flow Control Balance Valves

(1) Verify that each installed automatic flow control device matches the GPM indicated on the drawings.

(2) Verify that the actual pressure at each automatic flow control device is within the pressure limits specified by the valve manufacturer.

END OF SECTION

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SECTION 23 41 00 - PUMPS

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the specifications which affect the work of this section and which are hereby made a part of the work specified herein.

   B. All required motor starters shall be furnished with the respective pump.

   C. Electric motors shall be furnished with the pumps and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard.

   D. Shop drawings shall be submitted as required by Section 230300 and shall include complete pump specifications, installation and start-up instructions, current and accurate pump performance curves with the selection points clearly indicated, maintenance data and spare parts lists.

   E. Pumps shall be factory tested, cleaned and painted prior to shipment. Size, type, capacity and electrical characteristics are listed in the pump schedule.

   F. Insofar as possible, all pumps shall be by the same manufacturer.

   G. Pump shall have data plate indicating horsepower, voltage, phase, ampacity, pressure head, and flow rate.

   H. Special notes for pumps controlled by variable frequency drives:

      (1) Supplier shall provide the largest non-overloading impeller size for the specified pump motor horsepower, regardless of the specified pump head given on the pump schedule(s).

      (2) Pumps less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer’s instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer’s instructions. Install kit in strict accordance with manufacturer’s instructions.

2. MATERIAL

   A. BASE MOUNTED PUMPS

(1) Type: Horizontal, base mounted, end suction, single stage, flexible coupled, 175 PSI working pressure.

(2) Pump Body: Cast iron, flanged gauge and drain tappings, bronze fitted.

(3) Shaft: Stainless steel. Refer to special notes for pumps controlled by VFD's above for shaft grounding kit specification.

(4) Seal: Mechanical, carbon ring with ceramic seal.

(5) Motor: open, drip proof, re-lubricatable ball bearing. Minimum efficiency per NEMA Premium Induction Motor Efficiency.

(6) Impeller: Enclosed, balanced.

(7) Base: Structural steel.

(8) Coupling: Flexible with coupling guard.

(9) Manufacturers: Subject to compliance with the specified and scheduled requirements. Pumps by the following manufacturers will be considered:

Amtrol/Thrush
Armstrong/Aurora
Bell and Gossett
Federal Pump
Patterson
Sigmund
Worthington Pump
Weinman
Taco
FloFab
Grundfos

(10) SELECTIONS:

Refer to the schedule on the plans for base-mounted pump selections.

END OF SECTION

SECTION 23 42 00 - HVAC EQUIPMENT AND HYDRONIC SPECIALTIES

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide in complete working order the following heating, ventilation and air conditioning equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.

C. Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer’s Checklist.

D. Factory startup is required for all HVAC equipment. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. This shall include air handling units, boilers, chillers, cooling towers, VFDs, etc.

E. All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90 and/or International Energy Conservation Code 2015, whichever is more stringent.

F. Installation of all heating, ventilating and air conditioning systems shall be performed by a master HVAC contractor licensed in the state the work will be performed.

G. Note to Suppliers and Manufacturers Representative furnishing proposals for equipment for the project:

(1) Review the Controls Section of these Specifications (if applicable) to determine controls to be furnished by the equipment manufacturer, if any. The Contractor shall provide all controls with equipment unless specifically listed otherwise.

(2) Review the section of these specifications entitle: SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.

(3) Ensure that the equipment which you propose to furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.

(4) Determine from the Bid Documents the date of completion of this project and insure that equipment delivery schedules can be met so as to allow this completion date to be met.

(5) Where manufacturers' temperature controls are specified, they shall be in full compliance with International Mechanical Code Section 606 including automatic smoke shut down provisions.

(6) Provide factory start-up on site by a factory representative (not a third party contractor) for all HVAC equipment, including pumps, VFDS, boilers, chillers, cooling towers, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer.

(7) Provide training to the Owner by a factory representative for each type of equipment. Training shall be a minimum of eight (8) hours on site and the Engineer shall be notified one (1) week in advance of the training. Training shall only occur when the systems are complete and 100% functional. All training shall be video taped.

(8) Review the Section on Motor Starters and Electrical Requirements for Mechanical Equipment.

(9) Requirements for motors controlled by variable frequency drives:

a. All motors shall be inverter duty rated.

b. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

(10) Equipment incorporating energy recovery wheels shall be provided with an aluminum wheel with molecular sieve desiccant, 4 angstrom maximum sieve size. Wheels shall be certified in accordance with ASHRAE 84 or ARI 1060 standards.

(11) All condensate producing equipment shall be provided with a condensate trap as recommended by the equipment manufacturer and a condensate overflow switch.

(12) Provide a complete air tight enclosure with opening door that seals air tight for all filters on air moving equipment.

(13) All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

2. EQUIPMENT

A. WATER SOURCE HEAT PUMPS

(1) Tranquility® Large (TL) 084-300 60hz

General:

Furnish and install ClimateMaster Tranquility® Large (TL) Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped, and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI / ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI / ISO and ETL-US-C labels.

All units shall pass a factory acceptance test.

Basic Construction:
Vertical Units shall have one of the following air flow arrangements: Back Return/Top Discharge, Front Return/Top Discharge, Back Return/Front Discharge, Front Return/Back Discharge as shown on the plans. Units can be field converted without requiring new panels or belts. Units that cannot be field converted shall not be acceptable.

If units with these arrangements are not used, the contractor is responsible for any extra costs incurred by other trades. All units must have a minimum of two access panels for serviceability of compressor compartment.

Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) foil backed fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Units without foil-faced insulation in the air handling section will not be accepted.

Vertical heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish on access panels. The color will be Pewter. Both sides of the panels shall be painted for added protection.

Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

Vertical units to have discharge air duct collar. Filters housings and filters to be installed separately as indicated on drawings.

All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable.

Cabinets shall have separate knockouts on front and sides for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, connections on both sides (installer to choose side and plug opposite) and shall be securely mounted flush to the cabinet side allowing for connection of a flexible hose without the use of a back-up wrench. All water connections and electrical knockouts must not interfere with the serviceability of unit. Contractor must

ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

Provide UltraQuiet package shall consist of high technology sound attenuating material that is strategically applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions. Compressor is mounted on specially engineered sound-tested isolators.

The unit shall be supplied with extended range Insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Fan and Motor Assembly:

All units shall have belt-driven single or dual centrifugal fans. Fan motor shall be permanently lubricated with thermal overload protection. Units supplied without a permanently lubricated motor must provide external oilers for easy service. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. Airflow / Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no air filter shall NOT be acceptable.

Refrigerant Circuit:

All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the disconnect switch. Units that cannot be reset at the thermostat shall not be acceptable.

Hermetic compressors shall be internally sprung. The scroll compressors shall have a dual level vibration isolation system. The compressor(s) will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment isolated from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be a dual port balanced type with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

Unit shall include ClimaDry® II reheat option. Only modulating reheat that will adjust capacity based upon supply air temperature to provide "neutral" (72ºF, 22.2ºC) constant air temperature will be accepted. "Neutral" supply air temperature shall be provided regardless of entering loop water temperatures or refrigerant condensing pressures. Control of reheat must be accomplished via a humidistat or dehumidistat contact closure. Refrigerant circuit must be AHRI certified. Approved equal manufacturers may provide pre-engineered integrated modulating hot gas reheat within the unit cabinet. Any design costs and costs of field installed items shall be borne by mechanical contractor. Refrigerant circuits that are not AHRI certified when the reheat option is applied will not be accepted.

Drain Pan:
The drain pan shall be constructed of galvanized steel and have a powder coat paint application to further inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow complete and unobstructed drainage of condensate. Drain pan hose assembly can be connected to either side, drain outlet to be 1" FPT fitting. Choice of drain connection to only one side will not be accepted. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches will NOT be accepted.

The unit shall be supplied with stainless steel drain pan.

Electrical:
A control box shall be located within the unit compressor compartment and shall contain a 75VA transformer with load side circuit breaker protection, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor. Two compressor units shall have a solid-state time delay relay and random start to prevent both compressors from starting simultaneously.

The unit shall be supplied with electrical disconnect.

Solid State Control System (CXM):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.

c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or anti-freeze).
p. Air coil low temperature sensing.

Provide enhanced solid state control system (DXM). This control system features two-stage control of cooling and two-stage control of heating modes for exacting temperature and dehumidification purposes.

Control shall have all of the above-mentioned features of the CXM control system along with the following expanded features:

a. Removable thermostat connector.
b. Night setback control.
c. Random start on return from night setback.
d. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
e. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
f. Dry contact night setback output for digital night setback thermostats.
g. Ability to work with heat pump or heat/cool (Y, W) type thermostats.
h. Ability to work with heat pump thermostats using O or B reversing valve control.
i. Emergency shutdown contacts.
j. Boilerless system heat control at low loop water temperature.
k. Ability to allow up to 3 units to be controlled by one thermostat.
l. Relay to operate an external damper.
m. Ability to automatically change fan speed from multistage thermostat.
n. Relay to start system pump.
o. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

Digital Night Setback with Pump Restart (DXM w/ ATP32U03/04)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM controller with an ATP32U03/04 thermostat and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period.

An additional accessory relay on the unit DXM controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel (CXM/DXM):
Solid state control system shall communicate with thermostat to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat.

Temperature controls contractor shall provide field mounted controller.

Warranty:
ClimateMaster shall warranty equipment for a period of 12 months from start up or 18 months from shipping (whichever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Thermostats shall be supplied by temperature and controls contractor, refer to 235200.

(2) Tranquility® Large Water-To-Water Model “Tmw” 360-840 Series

General:
Furnish and install ClimateMaster “TMW” Water-Source Heat Pumps as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 30° to 120°F (-1.1° to 48.9°C) as standard. All equipment listed in this section must be rated in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-2). The units shall be certified to UL508A Standard. The units shall have an UL-US-C label.

All units shall pass a factory acceptance test.

Units shall be connected to building automated system (BAS).

Basic Construction:
All units must have multiple removable panels for serviceability of compressor compartment. Service panels shall have Allen head three-quarter turn quick release latches, and hand hold pockets for easy removal.

The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection. All interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation.

Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level

bacteria growth per ASTM G22. Unit insulation must meet these stringent requirements or unit(s) will not be acceptable.

The frame design shall consist of heavy gauge galvanized steel with powder coat finish. The module must have a low center of gravity base with cutouts for forklift or pallet jack and the frame must be designed to fit through a standard 36 inch doorway.

Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

Unit(s) shall have exterior indicator lights showing, 1) power (on-Green), 2) unit “fault” status (fault - Red), 3) compressor 1 operation (on-Green), and 4) compressor 2 operation (on-Green).

Refrigerant Circuit:
Units shall have sealed, isolated refrigerant circuits, each including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, a reversing valve, sight glass, filter dryer, load and source brazed plate refrigerant to water heat exchangers, and safety controls including a high pressure switch, low pressure switch (loss of charge), and low water temperature sensors. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit.

Hermetic compressors shall be internally sprung. The compressors will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge base plate. Compressors shall have thermal overload protection. Each compressor shall have isolation switch to aid start-up and service.

Heat exchangers shall be highly efficient, refrigerant to water, dual circuited, brazed plate design, constructed of 316 stainless steel; designed, tested, and UL stamped in accordance with ASME Section VIII pressure vessel code for 650 PSIG (4482 kPa) working refrigerant pressure. The heat exchangers shall be mounted to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up. The heat exchangers shall be mounted on two layers of noise attenuating rubber isolation pads which also acts as a thermal barrier. The heat exchangers shall be wrapped with 3/4 inch closed cell insulated blanket and closed cell insulation shall be provided on suction side refrigerant tubing to prevent condensation.

Water Circuit:
Unit shall have all internal water tubing insulated with closed cell insulation. Field connections shall be on the top so multiple units can be installed side by side. PT ports and heat exchanger flushing connections shall be accessable from back service panel. Load and Source water shall be tested and results approved by ClimateMaster to activate unit warranty.

Unit shall have Source Motorized Valve to prevent unit from locking out when water temperature is below 60ºF in cooling mode. Valve will automatically modulate to maintain compressor head pressure, for continuous unit operation.

Unit shall have Pressure Differential Sensors for Load and Source factory installed. Sensors are for proof

of water flow.

External of unit contractor must supply the following: minimum 60 mesh stainless steel screen strainers (for Load and Source), and pressure taps. All components should be isolated for ease of service.

Electrical:
The control box shall consist of a NEMA Type I enclosure with high and low voltage compartments, components include: low voltage connection block, power distribution block, compressor fusing, contactors, finger safe control fusing, transformer, isolation relays, status and alarm relay, 16-bit microprocessor DDC controller with built in native Building Automation System (BAS) communication protocols (BACnet and Modbus) two isolation switches to disable each individual compressor during start-up or troubleshooting, and external status indicating lights.

Solid State Control System:
DDC Controller shall be specifically designed to protect against building electrical system noise contamination, EMI and RFI interference. DDC control system shall be fully compatible with the Building Automation System via native BACnet or Modbus communication or BACview 6. Scheduling of the various compressors shall be performed by the microprocessor based controller. Controller shall provide following compressor safety protections: anti-short cycling, high voltage, low voltage, high discharge pressure, low suction pressure, high discharge temperature, low suction temperature, high source leaving water temperature, low load leaving water temperature, load low water flow, and source low water flow.

A compressor run time equalization sequence is provided to ensure even distribution of compressor run time. Units without even distribution of compressor run time are not acceptable. A load limit control shall be available to limit the number of compressors that can be energized at one time.

DDC Controller shall monitor and report the following for each refrigeration circuit:

a. Discharge pressure and temperature faults.
b. Suction pressure and temperature faults.
c. Compressor winding high temperature fault.
d. Low Load leaving chilled water temperature fault.
e. High source leaving water temperature fault.

DDC Controller shall monitor and report the following system parameters for the unit:

f. Chilled water entering and leaving temperature.
g. Condenser water entering and leaving temperature.
h. Load and Source low water flow.
i. Communication error
j. Electrical voltage/phase failure

Any failure condition shall cause a “fault” indication at the DDC Controller and shutdown of that compressor circuit. In the case of a system “fault” the entire unit will shutdown. When any fault occurs, the DDC Controller shall record conditions at the time of the fault, and store the data for recall. This information shall be capable of recall through BACview6 and displayed on the 4 line by 40 character, back-lit LCD. A history of faults shall be maintained including date and time for each fault (up to the last 100 occurrences). Internal leaving chilled water reset control will ensure that the parallel evaporators are operated above the freeze point for part load operation.

DDC Controller shall have flashing Light Emitting Diode (LED) for the following: compressor 1 fault, compressor 2 fault, sensors for compressor 1 out of range, sensors for compressor 2 out of range, compressor alarm, motorized water valve alarm, hot water temperature alarm, cold water temperature alarm, load flow failure, source flow failure, and main power phase loss.

Bacview 6 with cable must be used for setting controller at start up. Bacview 6 can also be used to operate, monitor, and change default settings, or as a service tool for the unit.

Warranty:
ClimateMaster shall warranty equipment for a period of 12 months from start up or 18 months from shipping (whichever occurs first). Warranty is not activated until 1). water test is approved, and 2). factory start-up is complete.

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Strainers:
The following strainers will be shipped loose: for field installation.
a. 3" FPT Y-strainer. 60 mesh screen. Provide one at each water inlet.

Phase monitor: Provide phase monitor shipped loose.

(3) Tranquility® Console Model "TRC" Size 09-18 60 Hz

General:
Furnish and install ClimateMaster Tranquility® "Console" Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

All units shall be fully quality tested by factory run testing under normal operating conditions.

Basic Construction:
Console units shall have one of the following air flow and piping arrangements: Front Inlet/Right-hand Piping; Front Inlet/Left-hand piping; Bottom Inlet/Right-hand piping; or Bottom Inlet/Left-hand piping as shown on the plans. Engineer must approve any changes in layout.

The cabinet, wall mounted back wrapper and subbase shall be constructed of heavy gauge galvanized steel with a baked polyester powder coat paint finish. Corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. Unit corrosion protection must meet these stringent

requirements or unit(s) will not be accepted. Color will be Polar Ice. Both sides of the steel shall be painted for added protection. Additionally, the wall mounted back wrapper shall have welded corner bracing. The easily removable cabinet enclosure allows for easy service to the chassis, piping compartment and control compartment.

All interior surfaces shall be lined with 1/4 inch (6.4mm) thick, 2 lb/ft3 (32 kg/m3) acoustic flexible blanket type glass fiber insulation with a non-woven, anti-microbial treated mat face. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Standard insulation must meet NFPA Fire Hazard Classification requirements 25/50 per ASTM E84, UL 723, CAN/ULC S102-M88 and NFPA 90A requirements; air erosion and mold growth limits of UL-181; stringent fungal resistance test per ASTM-C1071 and ASTM G21; and shall meet zero level bacteria growth per ASTM G22.

The cabinet shall have a 30º sloped top with aluminum rigid bar type discharge grille. Aluminum discharge grille shall be anodized charcoal grey in color including hinged control door. Cabinet shall have rounded edges (0.325 inch / 8.255 mm minimum radius) on all exposed corners for safety and aesthetic purposes.

Return Air Filter shall be 1” (25.4mm) fiberglass disposable type media for bottom return units (units with sub-base) or 1/8” (3.2mm) permanent cleanable type media for front return type units.

The unit shall be provided with a keyed lock on the control access door.

Provide UltraQuiet package shall be provided and consist of high technology sound attenuating material that is strategically applied to the compressor and compressor compartment in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions. Compressor is mounted on specially engineered sound-tested EPDM isolators.

Fan and Motor Assembly:
Fan and motor assembly shall be assembled on a slide out fan deck with quick electrical disconnecting means to provide and facilitate easy field servicing. The fan motor shall be multi-speed, permanently lubricated, PSC type, with internal thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall include a torsionally flexible motor mounting system or saddle mount system with resilient rings to inhibit vibration induced high noise levels associated with “hard wire belly band” motor mounting. The airflow rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no filter shall NOT be acceptable.

Refrigerant Circuit:
All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat

exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the disconnect switch.

Hermetic compressors shall be internally sprung. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced type with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

The unit will be supplied with internally mounted secondary pump for primary/secondary applications, specifically one-pipe systems. (Requires extended unit). The pump shall be capable of 4.5 gpm at 35 ft. of head.

The unit shall be supplied with extended range insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Piping:
Water piping shall terminate in the same location regardless of the connection and valve options.

Provide threaded MPT copper fittings.

Drain Pan:
The drain pan shall be constructed of stainless steel. Drain pan shall be insulated. Drain outlet shall be located at pan as to allow complete and unobstructed drainage of condensate. The unit as standard will be supplied with solid-state electronic condensate overflow protection.

Electrical:
Unit control shall be located under the hinged control door in the sloped top grille. Operating control shall consist of push buttons to select mode of operation “OFF”, “HEAT,” “COOL,” “AUTO”, Fan “AUTO” (fan cycles with compressor), Fan “ON” (continuous fan), Fan “LO” (low speed fan), and Fan “HI” (high speed fan). Temperature adjustment shall be accomplished via two push buttons, one labeled with an arrow up, and the other labeled with an arrow down. Control shall include an LCD display for display of temperature and setpoint.

A control box shall be located above the unit compressor compartment and shall contain operating controls as outlined in the paragraph above, 24VAC transformer, double-pole compressor relay, and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers.

Provide disconnect Switch, Non-Fused.

Solid State Control System (CXM):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.
c. Low voltage protection.
d. High voltage protection.
e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.

l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or anti-freeze).
p. Air coil low temperature sensing.

Provide enhanced solid state control system (DXM). This control system features two stage control of cooling and two stage control of heating modes for exacting temperature and dehumidification purposes.

This control system coupled with a multi-stage thermostat will better dehumidify room air by automatically running the heat pump's fan at lower speed on the first stage of cooling thereby implementing low sensible heat ratio cooling. On the need for higher cooling performance the system will activate the second stage of cooling and automatically switch the fan to the higher fan speed setting. This system may be further enhanced with a humidistat.

Control shall have all of the above-mentioned features of the CXM control system along with the following expanded features:

a. Removable thermostat connector.
b. Night setback control.
c. Random start on return from night setback.
d. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
e. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
f. Dry contact night setback output for digital night setback thermostats.
g. Ability to work with heat pump or heat/cool (Y, W) type thermostats.
h. Ability to work with heat pump thermostats using O or B reversing valve control.
i. Emergency shutdown contacts.
j. Boilerless system heat control at low loop water temperature.
k. Ability to allow up to 3 units to be controlled by one thermostat.
l. Relay to operate an external damper.
m. Ability to automatically change fan speed from multistage thermostat.
n. Relay to start system pump.
o. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

Digital Night Setback with Pump Restart (DXM w/ATP32U03/04)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM controller with an ATP32U03/04 thermostat and an external, field-provided time clock. The external time

clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period.

An additional accessory relay on the unit DXM controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel (CXM/DXM):
Solid state control system shall communicate with remote thermostat with fault indicator, to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat. Temperature controls contractor shall provide field mounted controller.

Warranty:
Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Temperature and controls contractor shall provide thermostats.

Subbase Grille:
Decorative louvered grille covers the front of subbase including the large return air opening. Order separate and field attach.

(4) Tranquility® Model “Ts” Size 006-070 60hz

General:
Furnish and install ClimateMaster Tranquility® “TS” Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

All units shall pass a factory acceptance test.

Basic Construction:
Horizontal Units shall have one of the following air flow arrangements: Left Inlet/Straight (Right)

Discharge; Right Inlet/Straight (Left) Discharge; Left Inlet/Back Discharge; or Right Inlet/Back Discharge as shown on the plans. Units must have the ability to be field convertible from straight to back or back to straight discharge with no additional parts or unit structure modification. Horizontal units will have factory installed hanger brackets with rubber isolation grommets packaged separately.

Vertical Units shall have one of the following air flow arrangements: Left Return/Top Discharge, Right Return/Top Discharge, Left Return/Bottom Discharge, Right Return/Bottom Discharge as shown on the plans.

All units (horizontal and vertical) must have a minimum of three access panels for serviceability of compressor compartment.

Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) foil faced fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream.

The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection.

Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22.

All horizontal units to have factory installed 1” (25.4mm) discharge air duct collars. Vertical units to have field installed discharge air duct collar, shipped loose. If units with these factory-installed provisions are not used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions. All filter racks installed by mechanical controls are not integrated unit.

All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable. All filters will be installed in separate filter rack installed by return ductwork.

Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

UltraQuiet package (available on TS018-070 Units) shall be provided and consist of high technology sound attenuating material that is strategically applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions

The unit shall be supplied with extended range Insulation option, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Fan and Motor Assembly:
Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units shall have a direct-drive centrifugal fan. The fan motor shall be 3-speed, permanently lubricated, PSC type, with internal thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor on small and medium size units (006-012) shall be isolated from the fan housing by a torsionally flexible motor mounting system with rubber type grommets to inhibit vibration induced high noise levels associated with “hard wire belly band” motor mounting. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. Airflow / Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings shall NOT be acceptable based on a dry coil and/or no air filter.

Provide ECM motors (sizes 018 to 070): The fan motor shall be an ECM variable speed ball bearing type motor. The ECM fan motor shall provide soft starting, maintain constant CFM over its static operating range and provide airflow adjustment on its control board. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. A special dehumidification mode shall be provided to allow lower airflows in cooling for better dehumidification. The dehumidification mode shall be selectable via a dip switch on the control board or may be controlled externally from a humidistat.

Refrigerant Circuit:
All units shall contain an EarthPure® (HFC-410A) sealed refrigerant circuit including a high efficiency scroll or rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube or all aluminum micro channel refrigerant to air $_{heat}$ exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the unit manufacturer supplied disconnect switch.

Hermetic compressors shall be internally sprung. The compressor shall have a dual level vibration isolation system. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. All units (except units with rotary compressors) shall include a discharge muffler to further enhance sound attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube or all aluminum micro channel construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils

range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced types with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

Drain Pan:
The drain pan shall be constructed of 201LN Stainless Steel to inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow unobstructed drainage of condensate. Drain outlet for horizontal units shall be connected from pan directly to FPT fitting. No hidden internal tubing extensions from pan outlet extending to unit casing (that can create drainage problems) will be accepted. The unit as standard will be supplied with solid-state electronic condensate overflow protection.

Vertical units shall be furnished with a PVC FPT condensate drain connection and an internal factory installed condensate trap. If units without an internal trap are used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions.

Electrical:
A control box shall be located within the unit compressor compartment and shall contain a 50VA transformer, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor.

Units shall be supplied with factory installed non-fused electrical service disconnect switch.

Solid State Control System (CXM):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:

a. Anti-short cycle time delay on compressor operation.
b. Random start on power up mode.
c. Low voltage protection.
d. High voltage protection.

e. Unit shutdown on high or low refrigerant pressures.
f. Unit shutdown on low water temperature.
g. Condensate overflow electronic protection.
h. Option to reset unit at thermostat or disconnect.
i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
j. Ability to defeat time delays for servicing.
k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
m. 24V output to cycle a motorized water valve or other device with compressor contactor.
n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
o. Water coil low temperature sensing (selectable for water or antifreeze).
p. Air coil low temperature sensing.

Solid State ECM Fan Control Board (60 Hz Units with ECM Fan Option Only):
Airflow selection shall be accomplished via 3 jumper switches on the ECM control board. Actual airflow shall be indicated by the CFM LED with each 100 CFM being represented by one flash of the LED. Airflow shall be automatically maintained (±5%) by the ECM motor regardless of external static pressure up to its maximum output capacity. A jumper shall allow selection of a special dehumidification mode, which reduces airflow in cooling by 25% to increase the latent capacity of the unit. A terminal shall be provided on the control board to allow an external humidistat to activate dehumidification mode.

Provide enhanced solid state control system (DXM). This control system features two stage control of cooling and two stage control of heating modes for exacting temperature and dehumidification purposes.

This control system coupled with a multi-stage thermostat will better dehumidify room air by automatically running the heat pump's fan at lower speed on the first stage of cooling thereby implementing low sensible heat ratio cooling. On the need for higher cooling performance the system will activate the second stage of cooling and automatically switch the fan to the higher fan speed setting. This system may be further enhanced with a humidistat.

Control shall have all of the above mentioned features of the CXM control system along with the following expanded features:

a. Removable thermostat connector.
b. Night setback control.
c. Random start on return from night setback.
d. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
e. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
f. Dry contact night setback output for digital night setback thermostats.
g. Ability to work with heat pump or heat/cool (Y,W) type thermostats.
h. Ability to work with heat pump thermostats using O or B reversing valve control.
i. Emergency shutdown contacts.
j. Boilerless system heat control at low loop water temperature.

k. Ability to allow up to 3 units to be controlled by one thermostat.
l. Relay to operate an external damper.
m. Ability to automatically change fan speed from multistage thermostat.
n. Relay to start system pump.
o. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

Digital Night Setback with Pump Restart (DXM w/ ATP32U03/04)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM controller with an ATP32U03/04 thermostat and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period. An additional accessory relay on the unit DXM controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel (CXM/DXM):
Solid state control system shall communicate with thermostat to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat.

Temperature and controls contractor shall provide field mounted controller.

Warranty:
Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Thermostats shall be provided by temperature controls contractor. Refer to 235200.

(5) Tranquility® Model “TE” Size 026-072 60hz

General:
Furnish and install ClimateMaster Tranquility® “TE” Water Source Heat Pumps, as indicated on the plans. Equipment shall be completely assembled, piped, and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.

Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. All equipment listed in this section must be rated and certified in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-1). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.

All units shall pass a factory acceptance test.

Basic Construction:

Vertical Units shall have one of the following air flow arrangements: Left Return/Top Discharge, Right Return/Top Discharge, Left Return/Bottom Discharge, Right Return/Bottom Discharge as shown on the plans.

If units with these arrangements are not used, the contractor is responsible for any extra costs incurred by other trades. All units (vertical) must have a minimum of three access panels for serviceability of compressor compartment.

Compressor section interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) acoustic type glass fiber insulation. Air handling section interior surfaces shall be lined with 1/2 in (12.7mm) thick, 1-1/2 lb/ft3 (24 kg/m3) foil-faced fiber insulation for ease of cleaning. Insulation placement shall be designed in a manner that will eliminate any exposed edges to prevent the introduction of glass fibers into the air stream. Units without foil-faced insulation in the air handling section will not be accepted.

The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection.

Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22. Unit insulation must meet these stringent requirements or unit(s) will not be accepted.

Vertical units to have field installed discharge air duct collar, shipped loose. If units with these factory-installed provisions are not used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions. Filter racks shall be installed in return ductwork by mechanical contractor. Filter rails are not required by unit.

All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream are not acceptable.

Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings, and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor shall be responsible for any extra costs involved in the installation of units that do not have this feature. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

UltraQuiet package shall consist of high technology sound attenuating material that is strategically applied to the compressor and air handling compartment casings and fan scroll in addition to the standard ClimaQuiet system design, to further dampen and attenuate sound transmissions.

The unit shall be supplied with extended range insulation option, which adds closed cell insulation to

internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchanger.

Fan and Motor Assembly:
Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units shall have a direct-drive centrifugal fan. The fan motor shall be an ECM variable speed ball bearing type motor. The ECM fan motor shall provide soft starting, maintain constant CFM over its static operating range and provide airflow adjustment in 25 CFM increments via its control board. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. A special dehumidification mode shall be provided to allow lower airflows in cooling for better dehumidification. The dehumidification mode may be constant or automatic (humidistat controlled). Airflow/Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil, and/or no air filter, shall NOT be acceptable.

Refrigerant Circuit:
All units shall contain an EarthPure®(HFC-410A) sealed refrigerant circuit including a high efficiency two-stage scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube or all aluminum micro channel refrigerant to air heat exchanger, reversing valve, coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure switch (loss of charge), water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the unit manufacturer supplied disconnect switch.

Hermetic compressors shall be internally sprung. The compressor shall have a dual level vibration isolation system. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. All units shall include a discharge muffler to further enhance sound attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.

Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube or all aluminum microchannel construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).

Refrigerant metering shall be accomplished by thermostatic expansion valve only. Expansion valves shall be dual port balanced types with external equalizer for optimum refrigerant metering. Units shall be designed and tested for operating ranges of entering water temperatures from 20° to 120°F (-6.7° to 48.9°C). Reversing valve shall be four-way solenoid activated refrigerant valve, which shall default to

heating mode should the solenoid fail to function. If the reversing valve solenoid defaults to cooling mode, an additional low temperature thermostat must be provided to prevent over-cooling an already cold room.

Drain Pan:
The drain pan shall be constructed of Stainless Steel to inhibit corrosion. This corrosion protection system shall meet the stringent 1000 hour salt spray test per ASTM B117. If plastic type material is used, it must be HDPE (High Density Polyethylene) to avoid thermal cycling shock stress failure over the lifetime of the unit. Drain pan shall be fully insulated. Drain outlet shall be located at pan as to allow unobstructed drainage of condensate. No hidden internal tubing extensions from pan outlet extending to unit casing (that can create drainage problems) will be accepted. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches will NOT be accepted.

Vertical units shall be furnished with a PVC FPT condensate drain connection and an internal factory installed condensate trap. If units without an internal trap are used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for his sub-contractor to install these provisions.

Electrical:
A control box shall be located within the unit compressor compartment and shall contain a 75VA transformer, 24 volt activated, 2 or 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve and fan motor wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote thermostat/sensor.

Units shall be supplied with factory installed non-fused electrical service disconnect switch.

Solid State Control System (DXM2):
Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall have the following features:

- Anti-short cycle time delay on compressor operation.
- Random start on power up mode.
- Low voltage protection.
- High voltage protection.
- Unit shutdown on high or low refrigerant pressures (loss of charge).
- Unit shutdown on low water temperature.
- Condensate overflow electronic protection.
- Option to reset unit at thermostat or disconnect.
- Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
- Ability to defeat time delays for servicing.

- Light emitting diode (LED) on circuit board to indicate high pressure, low pressure (loss of charge), low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.
- The low-pressure (loss of charge) switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
- 24V output to cycle a motorized water valve or other device with compressor contactor.
- Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
- Water coil low temperature sensing (selectable for water or antifreeze).
- Air coil low temperature sensing.
- Removable thermostat connector.
- Night setback control.
- Random start on return from night setback.
- Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
- Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
- Dry contact night setback output for digital night setback thermostats.
- Ability to work with heat pump (Y, O) or heat/cool (Y, W) type thermostats.
- Ability to work with heat pump thermostats using O or B reversing valve control.
- Emergency shutdown contacts.
- Boilerless system heat control at low loop water temperature.
- Ability to allow up to 3 units to be controlled by one thermostat.
- Relay to operate an external damper.
- Ability to automatically change fan speed from multistage thermostat.
- Relay to start system pump.
- 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.

To achieve full benefit of the two-stage compressor and ECM fan, a 2 Heat/2 Cool thermostat should be employed. Thermostat shall be provided by temperature controls contractor.

Digital Night Setback with Pump Restart (with ATP32U03, ATP32U04, ATC32U02C)
The unit will be provided with a Digital Night Setback feature using an accessory relay on the DXM2 controller and an external, field-provided time clock. The external time clock will initiate and terminate the night setback period. The thermostat will have a night setback override feature with a programmable override time period.

An additional accessory relay on the unit DXM2 controller will energize the building loop pump control for the duration of the override period. (Note: this feature requires additional low voltage wiring. Consult Application Drawings for details.)

Remote Service Sentinel:
Solid state control system shall communicate with thermostat to display (at the thermostat) the unit status, fault status, and specific fault condition, as well as retrieve previously stored fault that caused unit shutdown. The Remote Service Sentinel allows building maintenance personnel or service personnel to diagnose unit from the wall thermostat.

Temperature and controls contractor shall provide field mounted controller.

Warranty:
Climate Master shall warranty equipment for a period of 12 months from start up or 18 months from shipping (which ever occurs first).

Provide extended 4-year compressor warranty covers compressor for a total of 5 years.

Thermostats:
Temperature and controls contractor shall provide thermostats.

A. HOSE KITS

(1) HOSE KIT SIZES SHALL BE AS SCHEDULED ON THE DRAWINGS.

a. Provide a factory-assembled, one piece hose kit/piping package for supply and return connections for each heat pump.

b. Contractor shall provide and install Hays Hose Kit Piping Packages or Nexus Hose Kit Piping packages. Each kit shall be sized for 2.0 to 7.0 feet per second. Valves may be mounted in any altitude and do not require straight sections of pipe either upstream or down stream for proper operation. Griswold is not an acceptable manufacturer.

c. Each return side hose kit/piping package shall include the following:

1) Single piece Y - valve body for sizes ½" – 1-1/2", shall be constructed of hot forged brass with threaded inlets and outlets. 2" – 3" shall be constructed of bronze. 4" and larger shall be constructed of carbon steel with flanged inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure.

2) Single pressure/temperature test ports for verifying the pressure differential and system temperature, full flow design ball valve with blow out proof stems for shut off.

3) Manufacturer shall provide certified independent laboratory tests verifying accuracy of performance.

4) All valves shall be labeled with controlled flow direction, flow rate, PSID control range, manufacturer and model number, unit tagging.

5) Check valve.

d. Each supply side hose kit/piping package shall include the following:

1) Single piece Y - valve body for sizes ½" – 1-1/2", shall be constructed of hot forged brass with threaded inlets and outlets. 2-3" shall be constructed of bronze. 4" and

larger shall be constructed of carbon steel with flanged inlets and outlets. All valve bodies are suitable for a minimum of 400 PSIG working pressure.

2) Single pressure/temperature test ports for verifying the pressure differential and system temperature, full flow design ball valve with blow out stems for shut off.

3) Strainer shall be Y-type configuration furnished with hose connector blow down valve. Strainer screen shall be stainless steel mesh and easily accessible for cleaning without disconnecting hoses.

4) All valves shall be labeled with flow direction, manufacturer and model number, unit tagging.

e. Stainless Steel Braided Supply and Return Hoses: All hoses shall be equipped with end connections at terminal unit. All end connections shall be either permanently crimped swivel ends or butt welded to carbon steel end fittings to meet stated pressure ratings. Operational temperature shall be rated from fluid freezing to 200 degrees F. Minimum burst pressure shall be four times the working pressure. Furnish with field flushing connection fitting. ½" to 1-1/4" shall be reinforced, fire retardant EPDM rubber, bonded to the inside wall of braiding. 1 ½" and larger shall be a corrugated type 321 stainless steel tube.

f. Flushing Bypass: Provide with means at each heat pump to flush system completely while allowing no fluid flow through heat pump. Also see "Start-up and Flushing" instructions in this section.

g. Condensate Hose Kits: Contractors Option: Manufactured ¾" tubing x 54" long clear flexible plastic hose, with molded P-trap, fittings, couplings and clamps. All condensate drains larger than ¾" shall be field fabricated by contractor to allow for flexible movement. All sizes shall match sizes indicated on drawings.

h. Warrantee: Manufacturer shall warrant all components, for no less than five (5) years from date of purchase. Manufacturer shall warrant steel braided hose for no less than three (3) years from date of substantial completion.

B. VENTILATING FANS

(1) Ventilating fans shall be of the type, capacity, size, etc. here-in-after scheduled. Catalog numbers are listed as design criteria only. Alternate selections will be accepted provided quality, function, etc. are equivalent. All fans shall be UL listed, complete with all required disconnects and starters and shall be AMCA rated and certified. Model numbers listed are Greenheck, acceptable alternates are Penn, Carnes, Acme, Shipman, Jenn-Aire, Loren-Cook, and Twin City. The Architect shall select the color for all exposed fans.

(2) Selection

Refer to the schedule on the plans.

C. DEDICATED OUTSIDE AIR UNIT OA-1

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Design, performance criteria, controls, and installation requirements for indoor mounted Custom Air Handling Units.

1.2 REFERENCES

A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings
B. AMCA Publication 99 – Standards Handbook
C. AMCA Standard 203 – Field Performance Measurement of Fan Systems
D. AMCA Standard 210 – Laboratory Methods of Testing Fans for Performance Rating
E. AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans
F. AMCA Standard 500 – Laboratory Methods for Testing of Dampers and Louvers
G. ARI Standard 410 – Forced Circulation Air-Cooling and Air-Heating Coils
H. ANSI/ASHRAE Standard 111 – Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
I. ASHRAE Standard 52.1 – Dust-Spot Procedures for Testing Air-Cleaning Devices
J. ANSI/ASHRAE Standard 52.2 – Method of Testing Air-Cleaning Devices for Removal Efficiency by Particle Size
K. ANSI/ASHRAE 15 – Safety Standard for Refrigeration Systems
L. ANSI/ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality
M. ANSI/ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential
N. ARI 1060 – Performance Rating of Air to Air Energy Recovery Ventilation Equipment
O. ASTM A-653 – Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process
P. ASTM B117 – Standard Practice for Operating Salt Spray Apparatus
Q. IBC 2006-2012 – International Building Code
R. NEMA MG1 – Motors and Generators
S. NFPA 70 – National Electric Code
T. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
U. UL 900 – Test Performance of Air Filters
V. UL 1995 – Standard for Heating and Cooling Equipment

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1
B. Submittals shall include the following:
   1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
   2. Cabinet material, metal thickness, finishes, insulation and accessories.

3. Ladder-type schematic drawing of the power and auxiliary utility field hookup requirements, indicating all items that are furnished by the manufacturer.
4. Manufacturer's performance of each unit. Selection shall indicate, as a minimum, the following:
   a. Fan curves with system operating conditions indicated.
   b. Certified coil performance ratings with system operating conditions.
   c. Calculations required for base rail heights to satisfy condensate trapping requirements of cooling coil.
   d. Filters with performance characteristics.
   e. Rated load amp draw.
   f. Approximate unit shipping weight.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALIFICATIONS

A. Manufacturer shall be a company specializing in the design and manufacture of air handling equipment and in business for no less than 15 years.
B. Each unit shall bear an ETL label, conforming to UL Standard 1995.
C. Units shall comply with the requirements of UL 1995 and NFPA 90.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the supervision of the owner in accordance with the manufacturers Operation and Maintenance Instructions.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

1.8 WARRANTY

A. The complete unit shall be covered by a parts only warranty issued by the manufacturer covering the first year of operation. The warranty period shall start on the date of equipment startup or six months after the date of shipment, whichever occurs first.
B. The installing contractor shall provide labor warranty during the unit's first year of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

1) Basis of design is ClimateCraft. To be approved, manufacturers shall meet or exceed performance and construction aspects as described and detailed herein. Submittal is to be in sufficient detail to determine equivalency.

2.2 GENERAL

A. Units shall be completely factory assembled and tested with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. The equipment's cooling, heating, humidifying, ventilating, exhausting capacity and performance shall meet or exceed that shown on the schedule. Tags and decals to aid in service or to indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and Maintenance manuals shall be furnished with each unit.

2.3 CABINET CONSTRUCTION

A. Cabinets shall be constructed in a watertight and airtight manner. The manufacturer's standard cabinet construction shall result in an ASHRAE/ANSI Standard 111 Leakage Class 5 rating, or better, as measured in accordance with AMCA Standard 210. A leakage rate as a percent of airflow shall only be submitted following calculation at specific project conditions. Maximum casing leakage (cfm/100 ft^2 of casing surface area) = CL X $P^{0.65.}$ Published leakage rates at generic conditions shall not be submitted.

B. Casing deflection shall not exceed L/200 at +10.0 w.g. in all positive pressure sections and -10.0 w.g. in all negative pressure sections where L is defined as the panel span. Panels shall be designed to deflect no more than 1/200 (.0005” per inch) of span under operating design conditions when measured at the panel span. Casing shall be rated for 1.0% leakage at 1.5 times the operating pressure with a maximum overall pressure of 10” w.g.

C. The unit shall be constructed on a 5"welded structural tubular steel base. Base tubing shall be cold-formed carbon steel, electric resistance welded. Formed intermediate cross members shall be constructed of hot rolled 12-gauge galvanized steel. After fabrication, the base frame shall be thoroughly cleaned and coated with high solids, polyamide epoxy paint system for superior corrosion resistance.

D. Units shipped in multiple sections shall be engineered for ease of field assembly. Gasket supplied with the unit shall be a high quality weather resistant closed-cell EPDM sponge rubber. Each section shall include a permanent label to aid in proper field assembly. All gasket and necessary assembly hardware shall ship loose with unit. Floors shall be designed to deflect no more than 1/200 of span under operating conditions.

E. Floors

   a. Shall be fabricated of 16-gauge G-90 galvanized steel. All floor sheets shall be isolated from the base assembly with an EPDM thermal break gasket.

   b. Floors shall be insulated with a two-part polyurethane water impervious foam insulation. If glass fiber insulation is used, a 20-gauge type 304 stainless steel under liner shall be provided.

   c. Under liner shall also be provided when bottom of unit is used as an air tunnel. Under liner shall be fabricated of 16-gauge G-90 galvanized steel

F. Wall and roof panels

   a. Panels shall be 2” thick double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal. Air handling manufacturers using caulk to seal panels must include an owner witnessed field leakage test. The test shall require the unit to be field design air flow tested and cabinet leak tested for 1.0% at 1.5 times the operating pressure.

   b. Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 5/16” bolts

that can be removed and refastened. Panel attachment with screws is not acceptable. All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.

c. For long term durability, exterior panels shall be a minimum 16-gauge G60 galvanized steel pre-painted with a baked on polyester-ceramic paint system that passes a 1,000 hour ASTM B-117 salt spray resistance test and 3000 hour ASTM G-23 accelerated weathering test.

d. Interior liners shall be a minimum 20-gauge G90 galvanized steel. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

G. Insulation

a. All wall and roof panels shall be insulated with an injected foam insulation with an R value of 6.6 per inch. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel seam. Insulation shall fill the panel without voids. Panels shall have a minimum 20-gauge G90 galvanized steel solid interior liner.

H. Access doors shall be provided into all sections of the air-handling unit as indicated in the plan documents. Doors shall be sized as shown on plan drawings, shall be a minimum 2” thick with R13 polyurethane foam insulation and shall be double wall construction using the same material type as the corresponding section. Doors shall comply with the requirements of UL 1995 and NFPA 90. The door frame shall be 0.125” extruded 6063-T5 aluminum. Each door shall be mounted with adjustable die cast aluminum hinges. All doors and mounting frames shall incorporate a thermal break design and the doors shall seal to a replaceable extruded EPDM sponge rubber gasket. Doors shall open against static pressure or shall include a pressure relief feature on the door latch.

a. The door latch assembly shall consist of a roller cam compression arm with a chrome plated steel inner handle and glass fiber/nylon composite outer handle. One {tool operated} lock shall be provided on each fan section access door. All doors shall have a minimum of two latches.

b. A 10”x12” thermal pane viewing window with one wire mesh safety glass pane and one clear pane shall be provided. The frame shall have a no-through-metal thermal break design. Viewing windows shall be on all doors serving fan array motors. Windows on doors exposed to unit mounted UVC light shall use glass that is resistant to UVC transmission.

I. The entire unit, including walls, roof, doors, joints, and seams shall include thermal break construction. This construction shall be supported by tested performance producing no condensation on the exterior surface when the air tunnel temperature is 50°F DB under the following exterior conditions:

i. $(Th - 50) / (Th - Tdp) < 3.4$

b. Th = Ambient dry bulb temperature (°F) external to housing

c. Tdp = Ambient dew point temperature (°F) external to housing

2.4 FAN ASSEMBLIES – DIRECT DRIVE FAN ARRAY

1) Approved manufacturers: ClimateCraft, Daikin, and Trane

a) Fan Arrays shall be direct-drive, non-overloading SWSI plenum fans designed for industrial duty and suitable for continuous operation.
   i) Fans shall be arranged in an array using one or more welded structural steel assemblies and shall be of the size and quantity specified in the unit schedule. Screwed or riveted frames are unacceptable. Fan assemblies shall be attached directly to base structural members.
   ii) Fan wheels shall have a minimum of 12 airfoil blades for superior sound characteristics and shall be constructed of aluminum to reduce rotational weight and vibration. Fan blades shall be extruded aluminum for uniformity and improved vibration characteristics.
   iii) Each fan and motor assembly shall be independently isolated within the structural assembly using 1-inch deflection spring isolators. Isolators shall be mounted in a three-point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. If hard mounted or rubber in shear is used in place of internal spring isolations, external isolation of the entire unit is required. Isolation system shall be seismic rated.
   iv) A fan inertia base shall be provided or the fan structure shall exceed an equivalence of 2x mass of the total rotating parts of the fan array. Fan and motor assemblies shall be designed such that no natural frequencies exist within the operating RPM range of the fan, eliminating the need for "lockout" frequency settings in the variable speed drive. The purchasing contractor will be responsible for all costs associated with externally isolating any unit that does not include individual fan isolation.
   v) All fan arrays shall meet the minimum motor efficiency, maximum brake horsepower and total motor horsepower values scheduled. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed. Manufacturer must ensure maximum fan RPM is below the first critical speed. Fans shall be Class 3 construction.
   vi) All fan and motor assemblies shall be dynamically balanced by the manufacturer to a maximum allowable vibration of 0.040 inches per second at design RPM and a maximum 0.080 inches per second overall vibration limit to bring the fan balance in conformance to a BV-5 Grade G1 per ANSI/AMCA 204. In addition, the manufacturer shall insure that no critical frequencies exist in the fan operating range by varying motor speed in 1Hz increments from design RPM to 50% of design RPM.

b) Unloading
   i) Supply fans shall be provided with unloading capability to allow fan modulation without surge from 100% to 25% with a duct static pressure control set point of 1.25" w. g. There shall be no static pressure or intake plenum losses or any horsepower penalty associated with the system.
   ii) The technology shall be a self-contained system independent of the building system temperature controls. No powered actuators or control signals shall be required. Any control points required to operate the unloading sequence shall be wired by the AHU manufacturer to a single point of control for the building automation system to interface. If control points are required, coordination with the BASD manufacturer on control sequence responsibilities shall be required at time of submittal approval.
   iii) They system shall provide a positive shutoff for each fan in case of a fan failure. Each fan shall be provided with an isolation or backdraft damper to prevent bypass in the event of a motor failure. Blank off plates requiring manual installation are not acceptable.

iv) Fan cycling to allow stable part load operation shall be allowed only if a maximum of 50% of the fans will be cycled off at any time. Each fan is to be cycled in such a manner that all fans operate an equal number of hours in any given 168 hour (1-week) operating period. Control system shall indicate the individual fans operating and not operating. A separate control signal shall be required to indicate fan failure, separate from an indication that a fan is intentionally controlled to be off.

v) Fan curves shall be submitted; with the system curve indicating the minimum system operating static pressure and the point of fan surge.

c) Motors

i) Electrical characteristics and horsepower shall be as specified on the project schedule.

ii) Motors shall be Premium Efficiency per NEMA MG1 Table 12-12 ODP type, shall have NEMA Class F insulation, shall meet NEMA Standard MD-1 Inverter Duty rating and shall be designed to withstand 1600V peak voltage spikes and rise times ≥0.1 microseconds.

iii) Motors shall have grease lubricated ball bearings designed to deliver a minimum L10 life of 250,000 hours at full load and the maximum operating RPM of the associated fan. Grease zerks and spring loaded grease relief valves shall be provided in each motor to allow easy bearing lubrication without damaging the seals due to over lubrication. Permanently lubricated bearings are allowed if a spare motor per array is provided.

iv) For efficient operation in a direct drive application, motors shall be capable of operating greater than 60HZ to at least the design operating speed of the fan.

v) Motors shall be factory wired to a motor control center for connection to a VFD. The motor control center shall include for each motor circuit a control device providing overload protection, short circuit protection and a manual disconnect means, and all circuits shall be wired to a common main panel terminal block. Each control device shall include an auxiliary output capable of providing remote notification of a motor failure. All motors shall operate at all times and be controlled in unison, maintaining a consistent and uniform airflow pattern over coils, filters and other devices.

vi) Each motor shall be provided with a shaft grounding device to harmlessly bleed potential induced shaft voltages to ground.

d) Warranty

i) All rotating parts shall be warranted by the unit manufacturer for a full five (5) years from date of unit start-up. Parts warranties provided by third parties are not acceptable.

e) Provide the following options

i) Fans shall be provided with outlet guards to protect service personnel.

ii) Each array shall be provided with one inlet airflow blank-off plate to be used in case of a motor failure. Plate to include handles and latches for quick installation.

2) Fan Array Controls

A. Fan arrays shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

B. Each fan array in the air handling unit shall be provided with a factory installed airflow measuring instrument. Every fan in the array will have an airflow measuring device that is guaranteed by the unit manufacturer to have no impact on the fan airflow performance and will not increase the fan sound power. The output of the airflow measurement device on each fan shall be wired by the unit manufacturer back to a central processor mounted on the cabinet exterior that will add the flow from each fan to provide a total airflow for

the fan array. Using one air flow measuring device and multiplying by the number of fans provided is not acceptable due to lack of accuracy.
The central processor shall be able to detect and report a fan failure. Auxiliary contacts on the motors starters are not acceptable as fans can fail without tripping overloads. Current sensors wired into the central processors can be utilized. Acceptable manufactures are: AccAMP series ACSX, CR Magnetics model CR439, Greenheck FMS, NK Technologies series AS1.

Piezometric volume taps with pressure transducers are acceptable. Transducer accuracy shall be 1% of pressure reading from full scale down to 10% of full scale reading to improve accuracy to less than 0.5% of calculated flow from 100%-30% of flow. The square root linearization and conversion of the pressure signal to flow shall be done at the central processor. Acceptable pressure transducers are: MatrixMonitor™ Fan Sensor, Omega PX656, Greenheck FMS, Setra Model 239.

C. Measure the airflow back flowing through all failed fans in the array. The backflow shall be subtracted from the sum of the operating fans to provide an accurate delivered airflow for the entire fan array. The system measurement accuracy shall be $\pm$5% of measurement throughout the entire operating range of the fan array down to 15% of design flow. Systems with accuracy rated as a percentage of full scale are not acceptable. The system shall adjust for changes in barometric pressure and temperature to maintain accuracy in changing atmospheric conditions and at any altitude. The system shall be able to measure airflow and report it in units of ACFM or SCFM as selected by the user.
The system shall have the capability to communicate to the BMS with discretely wired analog signals or through an RS485 two wire multi drop network using the MODBUS protocol. All information available through the local keypad display unit shall be made available through the MODBUS or BACnet interface. At a minimum there shall be two locally scalable 0 to 10 VDC signals to report airflow and array pressure rise to the BMS. In addition, there shall be three SPDT relay outputs to report on the condition of the fan array. One relay will switch when the control is energized, one will switch in the event of fan failure detection and one will switch if fan surge is detected.

D. In addition to fan failure detection the system shall also be able to detect and report when any fan is in surge. The system shall have self-diagnostic capabilities and be able to report measurement and system errors. Individual and total flow measurements, entering air temperature and fan array pressure rise shall be available at a unit mounted key pad display.

E. Unit manufacturer shall supply and mount for each fan in the air handler a tri-axial accelerometer used to measure fan vibration. The output of each accelerometer shall be processed in real time through a FFT processor to provide frequency domain vibration for each fan. The vibration readings shall be reported in velocity and available for a frequency range that is a minimum of 3 times the operational speed of the fans. The system shall be capable of checking the fan vibration against user selectable vibration limits and reporting when those limits are exceeded. Each fan vibration sensor will be tied back to the airflow monitor where the individual fan vibration levels can be displayed on the local keypad display and the alarms and data can be transmitted to the BMS through the MODBUS communication link. Acceptable manufacturers are: MatrixMonitor™ Fan Sensor, IMI Sensors model 685B, Greenheck FMS, Metrix Instrument Co. model 440.

F. Each fan array in the air handler shall be equipped with a grease monitoring system to track the intervals between motor bearing greasing. The system shall monitor the motor

shaft speed for every fan motor in the array and integrate this data over time to determine the optimum elapsed time between bearing greasing. The system shall maximize the time interval between motor bearing greases while maintain proper lubrication of the bearings to maximize the motor life. The system shall notify the operator when it is time to grease the motor bearings through a locally mounted key pad display. The system will also estimate the number of days remaining until the motor bearings need to be greased. The system shall be capable of reporting the grease life information to the BMS through an RS485 two wire multi drop network using the MODBUS or BACnet communication protocol

2.5 FAN SPEED CONTROL

A. Each variable air volume supply and exhaust fan array shall be provided with an individual variable frequency drive. Drives shall be factory mounted and wired to the motor with adequate ventilation provided. The VFD shall be self-contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0 and 40-degree C. The VFD shall be 95% efficient at 100% rated output power, 60 Hz. The VFD shall be UL listed. Drives shall be mounted on the exterior of the unit housing or in a flush mounted, ventilated panel.

2.6 UNIT SOUND POWER

A. Fan sound power levels (dB) for the unit shall not exceed values as specified on the equipment schedule.

B. Unit manufacturer shall provide certified inlet, supply and casing radiated, sound power levels based on the final unit configuration.

2.7 COILS

A. Provide complete coil section(s) with service access door(s) as shown on the plan drawings. Coil connections shall extend through the section casing for ease of installation. Coil connections must be sealed from both the inside and exterior surfaces of the panel with the sleeve of the inner seal covering the pipe within the depth of the panel, all to minimize leakage and condensation. An integral double wall, stainless steel air seal which completely seals around the coil casing and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches.

B. Multiple, “stacked” coil arrangements must be constructed so as to allow independent removal of any coil without the removal of another within the coil bank.

C. All coils shall meet or exceed the capacities specified on the mechanical schedule and all water coil performances shall be certified in accordance with the AHRI Forced Circulation Air Heating and Air Cooling Coil certification program which is based on AHRI Standard 410. Face velocities shall not exceed those specified on the mechanical schedule.

D. All cooling coil sections shall include a double sloped drain pan constructed from 304L stainless steel. All corners shall be welded watertight. Coils shall rest on stainless steel supports. The pan shall have a minimum pitch of 2" from high point to the bottom of the drain outlet connection, providing at least a 1/8” per foot slope. The drain pan shall be insulated with a 2-part sprayed on polyurethane, water impervious foam. Insulation shall be applied to the entire under side of the drain pan and coil section base assembly. If multiple

stacked coils are used, intermediate drain pans are required. Intermediate pans shall be insulated and drained with 3/4" copper down-comers to the main pan.

E. Water coils shall be of a staggered tube design with high efficiency die formed corrugated plate-type fins for maximum performance. All coils shall be tested with 400 psig compressed air under clear water. Coils shall be designed to operate at 300 psig internal pressure and up to 250ºF. Tubes shall be 5/8" diameter, seamless 0.020" wall copper, mechanically expanded into full drawn fin collars for a continuous compression bond over the full finned length for high efficiency performance. Coil casings shall be a minimum 16-gauge stainless steel. Coil casing reinforcements shall be required for fin lengths over 42". Coil fins shall be 0.0075" thick aluminum. Coils shall be serviceable using 0.25" M.P.T. drain and vent taps on the supply and return headers. Threaded seamless red brass coil connections shall be brazed to copper supply and return headers.

2.8 FILTERS

A. Provide complete filter section(s) with filter racks and service access door(s) as shown on the plan drawings. Holding frames provided for medium efficiency applications will be accessible. Holding frames provided for high efficiency applications will be upstream accessible. Holding frames shall be constructed from heavy gauge galvanized steel and shall be equipped with polyurethane foam gaskets. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches

Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The holding frame shall be designed to accommodate standard size filters with the application of the appropriate type fastener. The filter rack shall be designed to use standard 24"x24" and 12"x24" filters only. Odd sized filters are not allowed. Holding frame assemblies shall be sized to meet or exceed the face area specified by the mechanical schedule.

B. Gauges

a. A Magnehelic differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter type. The gauge shall be a diaphragm-actuated dial type, 4¾" O.D., with white dial, black figures and graduations and pointer zero adjustment.

C. Medium efficiency pleated filters shall be 2" thick MERV 10 as rated by ASHRAE Standard 52.1 test methods. Filter media shall be of the non-woven cotton fabric type. Filters shall be UL900 Class 2 listed.

D. High efficiency bag filters shall be high capacity extended area disposable type. Each filter shall be 15" deep and consist of micro-fine synthetic media laminated to a non-woven backing. Filters shall be furnished with individual dust holding compartments and a corrosion resistant galvanized steel enclosing frame. The configuration of the dust holding compartments shall be such that it forms a supported compartment resulting in uniform velocities in the passages of the entering air and exit airside of the filter. The dust holding compartment shall be equipped with a galvanized entry faceplate which becomes an integral part of the enclosing frame. The filter efficiency shall be MERV 13 as rated by ASHRAE Standard 52.1 test methods. Upstream of the main filter in the same frame provide 2" thick

MERV 10 as rated by ASHRAE Standard 52.1 test methods. Filter media shall be of the non-woven cotton fabric type. Filters shall be UL900 Class 2 listed.

2.9 DAMPERS

A. Outdoor air, exhaust air, bypass air, and coil face and bypass dampers shall be airfoil low-leak dampers, Damper shall be opposed blade type. The frame shall be fabricated from 16-gauge galvanized steel. Damper shall meet the leakage requirements of ASHRAE Std. 90.1 and of the International Energy Conservation Code by leaking less than 3 CFM/sq. ft. at 1" of static pressure, and shall be AMCA licensed as a Class 1A damper.

2.10 ENERGY RECOVERY

A. Wheel Media: The enthalpy wheel shall be constructed of corrugated synthetic fibrous media with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated, bonded, or synthesized onto the media are not acceptable due to possible delamination or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized (+/- 0.032 in) in order to minimize wear on inner seal surfaces and to minimize cross-leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for air flow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by air flow are unacceptable due to the possibility of channeling and performance degradation. Wheel media must be tested and recognized by UL or equivalent. The minimum acceptable performance shall be as specified in the drawings/submittal. Media shall be cleanable with low temperature steam, hot water or light detergent without degradation of latent performance. The ECW or enthalpy wheel shall be AHRI certified in accordance with Standard 1060 and carry the AHRI mark.

B. Desiccant Material: The desiccant material shall be molecular sieve with maximum internal pore diameter of four angstroms ("4A") or smaller to minimize cross contamination and provide maximum selectivity for the water vapor molecule.

C. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment.

D. Wheel Seals: The wheel seals shall be contact brush style on both the perimeter and face to provide for maximum resistance to leakage. Seals must be easily adjustable.

E. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box-tubing depending on size and weight of the enthalpy wheel. Cassettes shall have a built in adjustable purge section to minimize cross contamination. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, externally mounted flange bearings or pillow block style depending on cassette size. Drive system shall consist of an AC drive motor and multilink belt.

2.11 SOUND ATTENUATORS

A. General

Furnish and install Commercial Acoustics Sound Attenuators of the models and sizes shown on plans and/or listed in schedule. Attenuators shall be the product of Commercial Acoustics

Division of Metal Form Manufacturing. Any change in this specification must be submitted to and approved by the architect/engineer, in writing, at least 10 days prior to bid due-date,

B. Sound attenuators shall be Type HP with Acoustically Transparent Interceptor Lining to prevent acoustical fill fiber erosion into the air stream.

C. Sound attenuators shall be located in the supply air tunnel downstream of the supply fan array and in the exhaust air tunnel downstream of the building exhaust filter rack.

D. Materials and Construction

Unless otherwise specified, attenuator shall be constructed entirely of G90 galvanized steel in accordance with applicable ASHRAE Guide recommendations for high pressure rectangular ductwork. Seams shall be lock-formed and mastic filled.

Outer casing shall be 22-gauge minimum galvanized steel. Internal baffles shall be 24-gauge minimum galvanized perforated steel and filled with inorganic glass fiber absorbent material of sufficient density and packed under at least 5% compression to eliminate voids due to vibration and setting to obtain catalog ratings.

Combustion rating for the silencer acoustic fill shall not be greater than the following UL fire hazard classification:

Flame Spread.....15

Fuel Contributed.....0

Smoke Developed.....0

Tested in accordance with UL Test Procedure 723.

Attenuators shall not leak or fail structurally when subjected to a different air pressure of 8-inches w. g. inside to outside of casing.

E. Acoustical Performance

Attenuator ratings shall be determined using the duct-to-reverberant room test method which provides for airflow in both directions through the test attenuator in accordance with ATSM specification E-477-84, or latest version there-of. The test set-up and procedure shall be such that all effects due to end reflection, directivity, flanking transmission, standing waves and test chamber sound absorption are eliminated. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self-Generated (SN) power levels both for Forward Flow (air and noise traveling in same direction, +), and Reverse Flow (air and noise traveling in opposite directions, -). Data shall be presented for tests con-ducted using silencers no smaller than 24W x 24H.

F. Aerodynamic Performance

Static pressure loss of attenuators shall not exceed those listed in the silencer schedule as the airflow indicates. Air-flow measurements shall be made in accordance with ASTM specification E-477-84, or latest version thereof, and applicable portions of ASME, AMCA, ADC airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented.

G. Certification

The manufacturer shall supply certified test data on dynamic insertion loss, Self-generated Sound Power levels, and Aerodynamic Performance for Reverse and Forward Flow test conditions to the architect/engineer, in writing, at least 10 days prior to bid due date. Test data shall be for a standard product. All ratings tests shall be conducted by a nationally recognized acoustic testing laboratory, in their facility, utilizing the same attenuator, and shall be open to inspection upon request from the architect/engineer. The testing laboratory shall be totally independent from the manufacturer. Data obtained in the manufacturers test

lab will not be acceptable unless substantiated by test reports conducted by a nationally recognized acoustic testing laboratory.

2.12 ELECTRICAL POWER AND CONTROLS

A. Unit operating voltage shall be 460V, 3 phase, 60Hz. All wiring and electrical equipment supplied by the manufacturer shall conform to and be installed in accordance with the requirements of UL1995.

Provide copper wires, bus bars, and fittings throughout, except internal wire of the control transformer may be aluminum if copper termination is provided. Identify power supply terminals with permanent markers. The maximum temperature of terminals shall not exceed 167°F (75°C) when the equipment is tested in accordance with its rating. Wiring shall be run in plated flexible metal conduit.

Mount a permanent nameplate on the unit to display the manufacturer, serial number and model number, date of manufacture, horsepower, current rating and voltage.

B. Furnish and install a NEMA 1 non-fused disconnect switch for the supply fan array and the exhaust fan array. Disconnect switches to be mounted on the exterior of the unit housing or in a flush mounted, ventilated panel.

C. Each section provided with a service access door shall be equipped with a vapor proof mini-fluorescent service light. All lights shall be completely installed and wired to a single switch. All switches shall be wired to the unit control panel. All switch boxes shall include a GFCI convenience receptacle. Lights shall be wired so they are functional whether the main power disconnect is in the on or off position.

2.19 UNIT TESTING AND QUALITY CONTROL

A. The fans shall be factory run tested to insure design integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. All direct drive fans shall be dynamically balanced as a complete assembly. Maximum vibration level shall be 0.080 inches/second peak velocity, filter-in readings taken with the filter tuned to the RPM of the fan. Units shall pass all quality control checks and be thoroughly cleaned prior to shipment.

B. The unit cabinet shall be tested to verify its cabinet leakage rating at design both positive and negative operating static pressure(s). Cabinet leakage shall not exceed a Leakage Class rating of 5 as defined by ANSI/ASHRAE Standard 111. Leak testing shall be performed by measuring the airflow pumped into (out of) the air-handling unit at the cabinet design operating static pressure. All unit openings shall be sealed. The air shall then be pumped into or out of the unit until the appropriate operating pressures are achieved. The testing shall be performed at the factory. A detailed report, including all data and test methods, shall be presented to the owner or his representative prior to equipment shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in strict accordance with manufacturer’s requirements, shop drawings, and Contract Documents.

B. Equipment rigging and assembly to be supervised by a manufacturer certified service organization. Provide for as long a period of time as is necessary to ensure proper assembly or onsite training but no less than 2 full days.

C. Adjust in alignment on concrete foundations, sole plates or other supporting structure. Level, grout, and bolt in place.

D. Coordinate electrical installation with electrical contractor.

E. Coordinate controls with control contractor.

F. Provide all appurtenances required ensuring a fully operational and functional system.

3.2 START-UP

A. Equipment start-up is to be supervised by the unit manufacturer or a manufacturer-certified service organization. Physical connections and start-up are provided by the installing contractor. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.

B. Provide complete Operation & Maintenance Manuals with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

D. HYDRONIC SPECIALTIES

(1) Manufacturers

Subject to compliance with the specified and scheduled requirements the following manufacturers will be considered, but not limited to:

Hoffman
Amtrol/Thrush
Armstrong/Aurora
Bell & Gossett
Patterson
Taco
Victaulic
Wheatley

(2) Hydraulic Separator PSH-1/Air Release Vessel

The hydraulic separator shall be designed and constructed per ASME Code Section VIII Div. 1. Provide Taco 5900 Plus Flex Balance Series Air Separator.

(3) Expansion Tank

The tank shall be constructed in accordance with the ASME Code for unfired pressure vessels and shall be suitable for 125 PSI water working pressure and 340ºF maximum water

temperature. The tank shall be a pre-charged, heavy duty butyl rubber diaphragm-type pressure vessel complete with standard tire charging valve. Refer to the plans for mounting orientation. Capacities shall be as scheduled on the drawings.

(4) Suction Diffusers

Provide at the inlet of each base mounted pump, a suction diffuser as manufactured by Bell and Gossett, Victaulic, Thrush, or approved equivalent. Each suction diffuser shall be equipped with a disposable fine mesh start-up strainer and an adjustable support foot to carry weight of inlet piping. Victaulic Series 731 G, W731G, Bell and Gossett Suction Diffuser, or equal.

(5) Flexible Connections

Provide at the inlet and discharge side of each base mounted pump, at each connection to major equipment requiring vibration isolation and where shown on plans, a flexible connector, Metraflex Metrasphere or Engineer approved equal. Flexible connectors shall be of the flexible neoprene and nylon or EPDM and suitable for 225 PSI working pressure and 230°F temperature. Couplings shall be installed per the manufacturer's recommendations, in close proximity to the source of the vibration.

Alternatively, in lieu of a flexible connector, three (3) Victaulic Style 77 flexible couplings may be used on suction side and discharge side of base mounted pumps (six Victaulic flexible couplings per pump).

(6) Pressure Reducing Valve

Provide at the point of connection of the domestic water line to the hydronic system and where shown on the plans, a pressure reducing valve by Thrush, Bell and Gossett, or Engineer approved equivalent. Such pressure reducing shall be provided with an inlet strainer and shall be set to maintain a pressure of 4 PSI in excess of that at the highest point in the hydronic system. Each pressure reducing valves shall be line sized.

(7) Manual Air Vents

Provide, where shown on the plans, at each rise in piping and where required for proper purging of the geothermal system provide manual air vents.

(8) Automatic Air Vents

Provide, where shown on the plans, automatic air vents.

Alternatively, in water piping systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and as required for the elimination of expansion loops. (In accordance with Victaulic recommendations and as approved by the Engineer). Where expansion loops are required in Victaulic piping systems, use Victaulic flexible couplings on the loop(s).

2. FACTORY START-UP REPORTS

A. Provide factory start-up on site by a factory representative (not a third party contractor) for all HVAC equipment, including pumps, VFD's, heat pumps, etc. Submit factory start-up reports to the Engineer. The Mechanical Contractor and the Controls Contractor shall have a representative on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action taken shall be submitted to Engineer.

B. At a minimum, the report submitted to the Engineer shall include the following data:

(1) Water Source Heat Pumps

a. High voltage power supply is correct and accordance with the unit nameplate.
b. The phasing of the unit is correct per the compressor rotation.
c. The field wiring and circuit protection is the correct size.
d. The low voltage control circuit wiring is correct per the unit wiring diagram.
e. The piping system is clean and complete.
f. Verify water flow is established and circulating through all units.
g. The condensate line is properly sized, run, trapped and pitched.
h. The indoor blower turns freely without rubbing.

Start-up checklist and log: Upon unit start-up, the following items shall be checked and logged for each water source heat pump. Note, the items listed below must be verified/checked before the system is put into full operation:

i. Entering fluid temperature (heat and cool mode)
j. Leaving fluid temperature (heat and cool mode)
k. Temperature differential (heat and cool mode)
l. Return air temperature (heat and cool mode)
m. Supply air temperature (heat and cool mode)
n. Water coil heat exchanger (water pressure "in" – psig) (heat and cool mode)
o. Water coil heat exchanger (water pressure "out" – psig) (heat and cool mode)
p. Pressure differential (psig) (heat and cool mode)
q. Compressor amps
r. Compressor volts
s. Compressor discharge line temperature (after 10 minutes)
t. Refrigerant charge (oz.)
u. Test drain pan operation
v. Check and note strainer condition.
w. Check and note filter condition.

(2) Outside Air Units/Energy Recovery Units

a. Fan rotation
b. Recovery wheel rotation
c. Confirm all wiring connections are correct

d. Confirm all field wiring is correct
e. Adjust belt tensions and alignments
f. Confirm pipe connections are correct
g. Confirm sequence of operation is correct
h. Confirm damper operation

(3) Water-to-Water Heat Pumps

a. High voltage power supply is correct and accordance with the unit nameplate.
b. The phasing of the unit is correct per the compressor rotation.
c. The field wiring and circuit protection is the correct size.
d. The low voltage control circuit wiring is correct per the unit wiring diagram.
e. The piping system is clean and complete.
f. Verify water flow is established and circulating through all units.

Start-up checklist and log: Upon unit start-up, the following items shall be checked and logged for each water source heat pump. Note: The items listed below must be verified/checked before the system is put into full operation.

g. Source entering fluid temperature (heat and cool mode)
h. Source leaving fluid temperature (heat and cool mode)
i. Load entering fluid temperature (heat and cool mode)
j. Load leaving fluid temperature (heat and cool mode)
k. Temperature differential (heat and cool mode)
l. Water coil heat exchanger (water pressure “in” –psig) (heat and cool mode)
m. Water coil heat exchanger (water pressure “out” – psig) (heat and cool mode)
n. Pressure differential (psig) (heat and cool mode)
o. Compressor amps
p. Compressor volts
q. Compressor discharge line temperature (after 10 minutes)
r. Refrigerant charge (oz.)
s. Check and note strainer condition.

3. WATER TREATMENT

A. SCOPE

Provide a one-year water treatment program for the DTS/DTR; HPS/HPR, GS/GP water loop systems. The one-year period shall start from the date of substantial completion. The program shall minimize corrosion, scaling, and prevent biological fouling of the piping system.

B. QUALIFICATIONS

Chemicals, service, and equipment shall be supplied by a single water treatment company for undivided responsibility. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of commercial/industrial water treatment for at least 5 years, whose major business is in the field of industrial water treatment. The water treatment

company shall have regional water analysis laboratories, service department, and full time representatives located within the trading area of the job site or facility.

Water treatment company shall be Bluegrass Kesco, Nalco, American Water Treatment.

C. SERVICE

Provide quarterly field service and Owner consultation. System water or fluid shall be tested for proper chemical parameters, clarity, and biological activity. If needed, provide chemical addition. Provide any laboratory and technical assistance required to achieve a successful program.

D. CHEMICALS

Provide one year's supply of the recommended chemical for scale and corrosion protection of the closed loop recirculating system. If needed, provide separate chemical to control microbiological growth in the system. Formulations shall not contain any ingredients which are harmful to system materials of construction.

E. EQUIPMENT

(1) Bypass Feeder

Provide one 5 gallon bypass chemical feeder for each system (DTS/DTR) and (GS/GR, HPS/HPR). Neptune DBF-5HP or approved equivalent.

(2) (DTS/DTR) and (GS/GR, HPS/HPR) Loop Filter.

Harmsco HIF or WB series fluid filter. Refer to schedule on the drawings for selection. Provide with a total of three sets of filter cartridges.

F. REPORTS

A summary of water or fluid quality and treatment shall be provided in writing to the Owner and Engineer after each quarterly site visit. Results of quarterly biological activity tests shall also be provided to the Owner and Engineer.

4. GEOTHERMAL AND HEAT PUMP SYSTEM CLEANING

A. GENERAL

The heating/cooling system for this contract is a hydronic heat pump system and there are several precautions which must be observed during its installation. The Contractor is advised to read all of the manufacturer's instructions prior to commencing the installation.

B. SYSTEM START-UP

The Contractor shall include as a part of his work a factory system fill and start-up by an authorized Factory Representative of the unit manufacturer.

C. CLEANING AND FLUSHING HYDRONIC HEAT PUMP PIPING SYSTEMS

(1) During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.

(2) After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil and any and all other material foreign to the water.

(3) Before chemical cleaning and sterilization of the entire system, the loop field shall be flushed and purged until free of dirt, debris, and air. During the chemical cleaning and sterilization process the supply and return run-outs shall be temporarily connected together at each heat pump location.

(4) After purging of the field loop the Contractor shall add an approved system cleaning solution at the recommended concentration to the entire system. Circulate the system with cleaner for the time recommended by the chemical manufacturer. After prescribed circulation time, flush the system until cleaner is removed.

(5) After chemical cleaning, the entire system shall be sterilized. Introduce a solution of sodium hypochlorite to achieve a chlorine residual of 25 to 50 ppm. Maintain this chlorine level for 12 to 24 hours. Flush out system until chlorine residual in system equals that of the makeup water.

(6) After the system has been completely cleaned and sterilized as specified herein, the individual heat pumps shall be connected permanently to the supply and return runouts and the system filled for operation under normal closed loop conditions. Within 48 hours of the completion of the sterilization implement a water treatment program to passivate all metal surfaces.

5. HVAC SYSTEM START-UP PROCEDURE

A. GENERAL

(1) The goal of this procedure is for a few units to run as much as possible with the coils as cold as possible to "wring out" the water and allow it to drain away in the condensate drain pans. Allowing all units to cycle on and off, running for short periods of time, does not dehumidify the air in the building. Starting the system without following the steps outlined will raise the relative humidity in the building and most likely cause condensation on some of the building surfaces and HVAC system that the Contractor will be responsible to correct.

(2) The high humidity and condensation occurs in school buildings at start up primarily because the building is only partly occupied (or not occupied) when the HVAC system is started. Most people believe that the answer to this problem is to turn the thermostats down very low. The assumption is that cold air will not hold moisture. That is not true. What happens is that the thermostats are quickly satisfied thermally because there is very little cooling load on the building and the cooling equipment. The terminal units then only have to run for a very short period of time to keep the thermostats satisfied and the relative humidity of the air is in fact raising. The goal is to cause the moist air to pass over coils which are cooling it and drying it without allowing more moist air to be introduced into the building.

(3) To reduce the always present high humidity start-up problem, we have devised this start-up procedure that will minimize the adverse effects of the start-up. As the building sits at start-up, all of the walls, floor, and ceilings are saturated with moisture from the air and also moisture is being released from the drying paint and curing concrete and mortar.

(4) The following procedure will slowly bring down the temperature and humidity in the lightly loaded building. It will also allow the HVAC equipment to more closely match the actual building load without students and equipment in use.

To reach these goals we require the following:

(1) Set 1/3 of the units (approximately every third unit) on 74°F (no lower). Set the other thermostats for a cooling setpoint of 90°F so the units will not cool. Override the controls so that the fans in all units will circulate air.

(2) Leave all of the interior doors open to allow the air to mix throughout the building.

(3) Close all exterior windows and doors.

(4) Turn off all exhaust fans and outside air units. Outside air unit exhaust and outside air dampers shall be closed.

(5) Leave all of the lights on in the building to provide a cooling load.

(6) Provide portable electric heaters or dehumidifiers in any room that shows signs of condensation.

Here is a list of things you should not do:

(1) Do not prop the exterior doors open during construction or while moving in furnishings.

(2) Do not start all of the units until students are starting school. When students start school the normal setpoints, schedules, and fan cycling shall begin.

END OF SECTION

SECTION 23 43 00 - REGISTERS, GRILLES, DIFFUSERS & LOUVERS

1. REGISTERS, GRILLES AND DIFFUSERS

   A. GENERAL

      Alternate R, G & D selections, other than manufacturers and models listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Price,Titus, Metalaire, Carnes, Anemostat, Kruegar, and Tuttle & Bailey. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. If Architect elects not to select color, all colors shall be off-white. Factory color samples shall be submitted with shop drawings.

   B. SELECTION

      Refer to the Selections Scheduled on the Drawings.

2. LOUVERS

   A. GENERAL

      Alternate louver selections, other than manufacturer and model listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Ruskin, Air Balance, Airline, Airstream, Louvers and Dampers and Penn. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect unless scheduled otherwise.

   B. LINTELS

      Provide lintels above all louvers as required. Refer to the lintel schedule provided by the Structural Engineer for all additional support required at wall penetrations.

   C. SELECTION

      Refer to the Selections Scheduled on the Drawings.

END OF SECTION

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SECTION 23 44 00 - SHEET METAL AND FLEXIBLE DUCT

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's HVAC Duct Construction Standards, Metal and Flexible, and its subsequent addenda. HVAC duct systems shall be fabricated and installed in accordance with the SMACNA duct construction standards (SMACNA-HVAC and SMACNA-Seismic) including Appendix B of the Seismic Restraint Manual Guidelines for Mechanical Systems. These references and plate numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging, accessories, etc. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

2. PRESSURE VENTS

   A. Provide a pressure relief vent in the supply air ductwork at each air handling unit. It shall be located between the fan outlet and the first manual or automatic (i.e., fire, fire smoke, or any motorized) damper or closure device. It shall be sized to relieve the duct air pressure below the rated pressure construction of the ductwork and above the working pressure of the fan. Provide a vacuum relief vent in the return and/or outside air ductwork at each air handling unit. It shall be located between the air handling unit casing and the first manual or automatic damper or closure device. It shall be sized to relieve the duct vacuum below the rated construction of the ductwork and above the working negative pressure of the fan. Automatic fan shutdown upon damper closure shall not be an acceptable protection for either overpressure or vacuum conditions. All duct relief dampers shall be of the automatic resetting type unless otherwise noted.

3. FILTER RACKS

   A. If separate filter grilles are specified for an HVAC unit the Contractors shall remove any unit mounted filters and blank off the unused filter access opening with sheet metal and seal air tight.

4. WALL PENETRATIONS

   A. Where ducts penetrate interior or exterior walls, the walls shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

5. PROTECTION DURING CONSTRUCTION

A. All ductwork openings shall be covered during construction to prohibit dust and dirt from entering the installed ductwork, air handling unit, terminal devices, etc. Provide temporary filters on all return grilles and duct openings if the units are running prior to the building being satisfactorily cleaned. The Contractor shall pay for duct cleaning if precautionary measures are not taken.

6. LOW VELOCITY DUCTWORK

A. General (Low Velocity)

(1) Double turning vanes shall be installed in all square turns and in any other locations indicated.

(2) Provide "spin-in" type fittings for all round ducts serving supply air diffusers where the duct branches off the rectangular duct main. The spin-in fitting shall not penetrate farther than 40% into the duct width.

(3) Cross-break all ducts where any duct section dimension or length is 18" or larger.

(4) Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.

(5) Splitter dampers shall be provided in all rectangular supply air duct tees. Damper blade operator shall extend a minimum two inches thru the insulation.

(6) Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc.

(7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do not suspend ducts from perlins or other weak structural members where no additional weight may be applied. If in doubt, consult the structural engineer.

(8) Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.

(9) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with "Duct Seal 321”. Apply per manufacturer's recommendations.

(10) Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.

(11) All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.

(12) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, coils, VAV boxes, fan sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(13) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.

(14) The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.

(15) Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.

(16) All fans and other vibrating equipment shall be suspended by independent vibration isolators.

B. Materials (Low Velocity)

(1) Ductwork, plenums and other appurtenances shall be constructed of the following:

a. Steel sheets, zinc coated, Federal Specification 00-S-775, Type I, Class E & ASTM A93-59T with G-90 zinc coating or aluminum alloy sheets 3003, Federal Specification AA-A-359, Temper H-14.

b. Exposed ductwork in finished spaces such as gymnasiums, etc., shall be dual wall ductwork.

(2) Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the IMC and SMACNA HVAC Duct Construction Standards - Metal and Flexible, or as follows whichever is more stringent.

ROUND DUCT		RECTANGULAR DUCT	
DIA.,	GAUGE	WIDTH, INCHES	GAUGE

INCHES			
3 TO 12	26	UP TO 12	26
12 TO 18	24	13 TO 30	24
19 TO 28	22	31 TO 54	22
29 TO 36	20	55 TO 84	20
37 TO 52	18	85 AND ABOVE	18

(3) Flexible ductwork which is uninsulated shall be corrugated aluminum. Use flexible ductwork only where indicated. No sections shall be greater than five feet in length. Ductwork shall be UL rated and in accordance with IMC.

(4) Insulated Flexible Duct (Use Only Where Indicated)

a. Owens/Corning or equivalent, 1 ½'' inch thick fiberglass insulation; flexible liner; with aluminum pigment vinyl vapor barrier facing. Insulated flexible duct shall meet Fire Hazards Standards of NFPA 90A and IMC, flame spread not to exceed 25, smoke develop and fuel contributed not to exceed 50 when tested in accordance with ASTM-E84. Minimum R-value of 6.0, tested in accordance with ASTM C177.71. Flexible duct may be used only for runouts and no sections shall be more than five feet in length.

b. When flexible duct is located in areas where it will be visible because the ceiling allows views to the ductwork above, the flexible duct shall be black. The black color shall be factory coloring and not field applied.

c. Flexible duct shall not be used in areas where there is no ceiling.

C. Double Wall Low Velocity Ductwork

(1) Install Double Wall Ductwork in the following areas:

a. Gymnasium
b. Cafeteria/Commons
c. Above areas with partial ceilings or clouds
d. Anywhere supply ductwork is installed exposed to view in spaces (other than mechanical rooms)
e. At all other locations indicated on drawings
f. Library Commons

(2) Prior to purchase/shipment of the ductwork, manufacturer shall provide as part of the submittal process scaled, field coordinated Autocad drawings of the complete system to be furnished. Drawings will indicate all system components including fittings, ductwork and manifolds. Drawings shall be available in an electronic format.

(3) Furnish and install where indicated double wall duct. The double wall duct shall be Eastern Sheet Metal, United McGill, Semco or approved equivalent. The duct shall have an inner shell, a 1-inch layer of fiberglass insulation and an outer pressure shell. For the Cafeteria/Commons, the duct shall include a 2 inch layer of insulation.

(4) Ductwork outer shell shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Any ductwork exposed to view shall be constructed of G90 galvanized steel, 20 gauge, and shall be supported as required with aircraft cables and self-tightening locks. Ductwork shall be constructed as specified in LOW VELOCITY DUCTWORK.

(5) Inner shell for spiral pipe shall be a perforated inner liner. The inner liner shall have 3/32" perforation with an overall open area of 23%.

(6) Inner shell for fittings shall be galvanized steel. All fittings shall be manufactured by the same manufacturer as the spiral pipe. Fittings shall be constructed a minimum of 22 Ga.

(7) The fiberglass liner shall have a maximum thermal conductivity (k) factor of 0.27 btu per hour per square foot per degree Fahrenheit per inch thickness at 75 degree F ambient temperature.

(8) All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which shall keep the inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

(9) All grille and register taps shall be factory manifolded. Field installed taps will not be allowed. Manifolded taps may be tack welded and caulked for appearance. Only taps for grilles and registers may be provided this way. All other fittings shall be full body welded.

D. Miscellaneous (Low Velocity)

(1) Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A; neoprene coated glass fabric; 20 oz. for low velocity ducts secured with snap lock.

(2) Turning Vanes: Barber-Colman, Titus, Waterloo, or equivalent; fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.

(3) Air Extractors: Metalaire Model 102-1 Carnes, Titus, Barb-Air or approved equivalent. Provide with operating hardware by Ventfabrics, Inc. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

(4) Splitter Damper: Splitter damper shall be constructed of 16 gauge galvanized steel. Provide with operating hardware by Ventfabrics, Inc. to include damper blade bracket, ball joint bracket and operator shaft. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

(5) Access Doors; In Ductwork: In ducts where indicated or where required for serving equipment, fabricated according to SMACNA recommendations and be equivalent to those manufactured by Air Balance, Vent Products or other approved equivalent. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils (water, electric, steam, etc.), and downstream side of VAV boxes and CAV boxes. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length.

(6) Access Doors; In Ceilings or Walls: Titus, Krueger, Milcor or approved equivalent with key locks.

a. In mechanical, electrical or service spaces. 14 gauge aluminum brushed satin finish, 1" border.

b. In finished areas.
14 gauge primed steel with 1" border. To accept the architectural finishes specified for the space.

Provide where required to access equipment, dampers, valves, filters, etc.

(7) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air volume dampers. Frames shall be 4" x 1 "x 16 gauge galvanized steel. Blades shall be 16 gauge galvanized steel, maximum of 6" wide. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(8) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air Round Damper. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20 gauge steel, 7" long. Damper blades shall be 20 gauge galvanized steel. Axle shall be 3/8" diameter steel. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(9) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3 hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall

be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16 gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. All fire dampers shall be dynamic. Static fire dampers are not allowed. Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2 hour rating or Ruskin Type DIBD 23 for a 3 hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.

7. HIGH VELOCITY DUCTWORK

A. Application (High Velocity)

(1) Variable air volume box inlet sized ductwork branches/run-outs serving single Variable Air Volume terminals shall be high velocity single wall ductwork.

(2) Constant air volume box inlet sized ductwork branches/run-outs serving single Constant Air Volume boxes shall be permitted to be high velocity single wall ductwork.

B. General (High Velocity)

(1) Provide flexible connectors at inlet and outlet of air handling equipment to accommodate a minimum of three times the operating pressure of the system.

(2) Duct dimensions indicated are required inside clear dimensions.

(3) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with Hardcast "DT" tape and Hardcast "RTA-50" adhesive installed in strict accordance with manufacturers recommendations.

(4) Ductwork shall be installed per SMACNA Medium or High Pressure Manual, whichever is applicable. (Latest Edition shall apply.)

(5) All hanger straps shall be 18 ga. minimum with reinforcement angles installed in strict accordance with SMACNA. Flat oval ducts shall be installed with 2"x2"x1/4" angles on top and bottom ducts 18" wide and larger. Use 1"x1"x3/16" angles on ducts under 18" wide.

(6) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA or the duct manufacturer, and/or as indicated. Test openings shall be placed at the discharge of all air handling units and at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(7) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating

of the wall. Provide an approved access panels at each fire damper located and sized so as to allow hand reset of each fire damper. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. Where access doors are installed in insulated ductwork, the access door shall be the insulated type.

C. Materials (High Velocity Single Wall)

(1) All round and oval high velocity ductwork shall be United McGill "Uni-Seal" or "Uni-Weld" ductwork or Semco, Dixie, Eastern Sheet Metal, Langdon, or approved equivalent as required by pressure rating of the system.

(2) Ductwork shall be spiral, lock-seam type and be constructed of galvanized steel.

DIAMETER (Or Equivalent Round Diameter For Oval Ducts)	METAL THICKNESS
3-14 Inches	26 Ga.
15-26 Inches	24 Ga.
27-36 Inches	22 Ga.
37-50 Inches	20 Ga.
52-60 Inches	18 Ga.

All duct fittings shall be fabricated by duct manufacturer. Duct fittings shall be minimum 20 gauge. All fittings shall be a minimum of one gauge heavier than the pipe size.

D. Air Leakage Testing of the Ductwork Systems

(1) It is the intent of this section to insure the ductwork installed has minimal air leakage.

(2) Air leakage testing shall be accomplished by an AABC or NEBB certified company. Refer to the Test & Balance specifications.

(3) It is the intent to test all ductwork. The duct systems which will require testing are as follows:

a. All supply air duct systems

b. All return air duct systems.

c. All exhaust air duct systems.

d. All outside air duct systems.

(4) Do not insulate the supply air systems prior to testing.

(5) The maximum allowable supply and outside air leakage rate is 2.5%**.)** of the systems design CFM when the ductwork is pressurized to 2.5" WG (Therefore, if a supply air system is tested, and the supply air fan rated capacity is 10,000 CFM, the allowable leakage is 250 CFM.) The maximum allowable return air and exhaust air leakage rate is 2.5% of the system design when the ductwork is pressurized to 1.50"WG.

(6) The entire outside air ductwork system shall be tested. On the VAV systems, the ductwork upstream of the VAV boxes shall only best tested.

(7) All exhaust air sheet metal ductwork associated with the system shall be tested. Flexible ductwork shall not be tested. Cap the main duct prior to the central equipment fan connection. Also cap the branch ducts which serve the diffusers, after the round branch air volume with sheet metal caps. Seal caps well to damper to avoid air loss at this location. This air loss, from the caps, is included in the noted leakage rate.

(8) The noted allowable leakage rate is the total allowable. It shall include leakage associated with the following:

a. All ductwork as described in above paragraphs.

b. Access doors

c. Volume dampers

d. Fire dampers

e. End caps used to seal ducts

(9) If any duct system fails a test, the contractor shall reseal the system. It shall then be retested until the duct system meets the leakage allowment at no additional cost to the owner.

(10) Carefully select the ductwork construction requirements and the type of duct sealant to be used as required to meet the leakage allowances. The sheet metal duct pressure classification is a minimum only. The contractor shall select the appropriate sheet metal pressure classification, duct sealant class and duct sealant materials to meet the project air leakage allowances.

8. KITCHEN RANGE HOOD EXHAUST DUCT

A. Ducts shall be constructed of 18 gauge stainless steel with liquid tight continuous external weld of all seams and joints where exposed. Where ducts are concealed, they shall be constructed of 16 gauge black steel with liquid-tight continuous weld of all seams and joints. Inside laps on duct joints shall project in a direction against the air flow.

B. Ducts shall be so constructed and sloped as to provide suitable drainage of grease to a collection point. At the base of each vertical riser, a residue trap shall be provided with provisions for cleanout.

C. Hand holes for inspection and cleaning purposes, equipped with tight fitting sliding or swinging doors and latches, shall be provided in horizontal sections of exhaust ducts. Such openings shall be at the sides of the horizontal run in order to prevent dripping of residue. Spacing of such openings shall not exceed 20 feet and shall be located at all offsets. Openings shall have a minimum dimension of 20" in width with a height equivalent to the duct height minus one inch.

D. Shop drawings of the kitchen rangehood exhaust ductwork shall be made and submitted to the appropriate reviewing agency. Any fees associated with this submittal shall be borne by this Contractor.

9. DISHWASHER EXHAUST DUCT

A. All exposed exhaust duct shall be 22 gauge stainless steel duct with liquid tight continuous external weld of all seams and joints. All concealed exhaust duct shall be 24 gauge aluminum with liquid tight joints. Provide dielectric connection between steel and aluminum ductwork. All ductwork shall be sloped so as to drain back toward the dishwasher.

10. DRYER VENT

A. Provide a dryer vent at all dryer locations indicated on the plans. Duct shall be 22 gauge aluminum with all joints sealed. Provide an aluminum wall or roof cap as recommended by the appliance manufacturer. Vent shall not exceed the equivalent length required by the dryer manufacturer or the IMC.

11. LAB EXHAUST DUCTWORK SERVING LABOROTORY HOODS, EF-8, ROOMS C022 AND C023

A. PVC Coated Galvanized Ductwork- All Exhaust Duct serving EF-8, Lab Hood, Louver.
B. All exhaust ductwork serving EF-8 shown in rooms C022 and C023 on floor plans shall be low velocity 4 milx 4mil PVC Coated galvanized duct. Ductwork shall meet all SMACNA requirements for 6” pressure class ductwork. The duct shall be transported, stored, and installed in accordance with SMACNA Advanced Cleanliness standards. Any scratches or imperfections observed in the PVC coating shall be repaired per the manufacturers recommended procedure or removed from the jobsite. No flexible duct shall be allowed on Exhaust systems.
C. All devices located within the exhaust air stream stainless steel or PVC Coated. This includes sound attenuators, screws, dampers, Exhaust Fans, Louvers, etc.

END OF SECTION

SECTION 23 51 00 - MOTOR STARTERS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. MOTOR STARTERS-GENERAL

   A. Where motor starters are required for mechanical equipment they are to be the responsibility of the Contractor furnishing the equipment as outlined herein.

   B. Motor starters shall be furnished by the Equipment Supplier with his equipment. Coordinate all requirements for starters with equipment suppliers and other trades.

   C. Motor starters shall be NEMA style. I.E.C.-style starters are not to be provided. Their sizing and installation shall be coordinated with the equipment manufacturer's requirements and in accordance with the National Electrical Code.

   D. Unless otherwise noted, provide combination starter/disconnects for all equipment requiring a starter.

2. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

   A. All mechanical equipment shall be provided for single point electrical connection unless specifically noted to the contrary. Refer to schedules and other sections of these specifications for further requirements. It is the responsibility of the Contractor to coordinate the electrical characteristics of all equipment with the electrical provisions indicated on the Contract Documents. The Contractor shall notify the Engineer in writing ten calendar days prior to bid of any discrepancy so a written clarification by Addendum may be made. If such notice is not given, the Contractor shall be responsible for any and all costs or delays associated with any changes required. Specification of equipment characteristics made during review of shop drawings shall not relieve the Contractor of this responsibility.

   B. The equipment manufacturer shall provide internally mounted fuses with his equipment, as required, to comply with the U.L. listing on the equipment name plate. (i.e., hermetically sealed compressors or equipment with name plate data that recommends or requires fuse protection.) See also, National Electrical Code, Article 440, and other applicable sections of the N.E.C.

   C. It is the Contractor's responsibility to furnish and install fusible or non-fusible disconnect switches or circuit breakers for disconnecting means as required by the Code for all electrically powered equipment. All power wiring from source, thru disconnecting means and motor starters to motor terminals or equipment junction box is to be furnished and installed by the Contractor. Each separate contractor engaged for the project shall coordinate with all other trades to ensure all necessary equipment and labor is included for fully functioning mechanical systems, installed per code requirements. Unless otherwise notes, provide combination starter/disconnects for all equipment requiring a starter.

   D. Final electrical connection of equipment shall be verified for proper voltage requirements in conjunction with the motor nameplate patch and actual wiring configuration. Any costs

associated with damage to appliances motors, equipment, etc., connected to incorrect supply voltage shall be borne by the Contractor.

E. Refrigeration condensing units with internal compressors shall be furnished with integral starter. The Contractor is to furnish and install a fusible disconnecting mains with fuses sized to motor nameplate requirements. Coordinate wiring, mounting and style of disconnect switch at unit in field.

F. All interlock or other control wiring, unless specifically noted otherwise, is the responsibility of the Contractor.

G. All equipment shall be suitably enclosed. All enclosures for equipment shall be rated and approved for the environment in which it operates. (i.e., NEMA 1, NEMA 3R, NEMA 7, NEMA 12, etc.) Verify the requirement with the installation condition if not indicated on the plans.

H. Observe the following standards for manufacturers of equipment and selection of components.

(1) Starters, control devices and assemblies: NEMA, U.L. - (I.E.C. style not acceptable)

(2) Enclosures for electrical equipment: NEMA, U.L.

(3) Enclosed switches: NEMA, U.L.

(4) All electrical work, generally: National Electrical Code

(5) All electrical work in industrial occupancies: J.I.C. standards

(6) All electrical components and materials: U.L. listing required.

I. Where required, the Contractor is to provide mounting rails or channels to install starters with code-required clearances. Framing shall be solidly anchored by welding expansion shields in masonry or other approved anchorage. Frames are to be constructed of steel angles or pre-manufactured channel systems such as Unistrut, Kindorf or B-Line Company. Framing material shall be pre-finished with corrosion-resistant material or painted with two coats corrosion-resistant oil-based enamel.

3. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 1/2 H.P OR LESS

A. This section describes requirements for small mechanical equipment such as (but not limited to) package terminal heating/cooling units, (water source heat pumps, etc.) VAV boxes, unit heaters, vertical and horizontal unit ventilators, exhaust fans, in-line fans, fan coil units, cabinet heaters and the like.

B. Small equipment with motor(s) of 1/2 H.P., single phase or less are generally not required to be furnished with NEMA-style starter(s), unless otherwise noted.

C. For such equipment, provide integral contactor or horsepower-rated relay where controlled by thermostat or other type of switch. Contactors or relays shall be as recommended by the manufacturer of the equipment, suitable for the service duty.

D. Provide transformer within unit as required to derive low voltage A.C. for thermostat control or derive from temperature controls panel, if available.

E. Provide internal fusing for unit motor and other loads in fuse block or in-line fuseholder. See also Article 2-B, this Section.

F. Where externally-mounted disconnecting means is required and would be impractical, unsightly or inappropriate in the judgment of the Engineer, disconnects shall be located within the unit. These disconnects may be fusible H.P.-rated snap switches or manual starters with overload elements, as required. Locate this and other electrical equipment within enclosure where easily accessible behind access panel or door on unit, and as acceptable to the electrical inspector or local authority having jurisdiction. Refer to mechanical equipment schedules for further information.

G. Where fractional horsepower duplex pumps such as water circulators, sump pumps, etc. are provided, they shall be provided with alternators, cordsets, etc., as required for a complete installation.

4. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 3/4 H.P. OR LARGER

A. This section describes requirements for mechanical equipment such as (but not limited to) exhaust fans, larger air handling units, cooling tower fans, water source heat pumps, chilled or hot water pumps, D.X. roof-top units, air compressors and the like.

B. Provide premium efficiency motors.

C. Equipment provided with motor(s) of 3/4 H.P. and larger, single or three-phase are required to be furnished with starters suitable for the load(s) specified. It is recommended that starters be furnished integrally with or mounted on equipment for field wiring by the Contractor. Where starters are furnished separate from equipment, furnish templates or rough-in diagrams to the appropriate contractor for his use in installation.

D. All starters shall be size 0 minimum. They shall be constructed and tested in accord with latest edition of NEMA standards. All starters shall be across-the-line magnetic type, unless indicated otherwise. On motors of 20 H.P. or greater rating, the supplier shall provide starters capable of limiting inrush currents. These shall be of the wye-delta, reduced voltage open-transition type, or electronic controlled, as required. Do not utilize closed transition starters unless specifically indicated.

E. Magnetic starters shall be furnished with the following characteristics and accessories as a minimum. See other sections of these specifications and mechanical schedules for further requirements.

(1) Contacts shall be silver-alloy, double-break type. Contacts shall be replaceable without removal of wiring or removal of starter from enclosure. Number of contacts shall be as required for service indicated. Contacts shall be gravity dropout type, positive operation.

(2) Coil voltage shall be 120 volts, A.C., 60 HZ or less, as required to suit control systems available voltages. Coils shall be of molded construction, rated for continuous duty. Provide coil clearing contact as required.

(3) Provide control transformer of adequate K.V.A. as required on all starters with line-to-line voltages higher than 120 volts A.C. Provide fuse block and slow-blow fuse to protect control transformer per NEMA, N.E.C. and U.L.

(4) Provide hand-off-auto selector switch in face of starter, wired into hand and off switch positions. Auto position (if needed) to be field wired as indicated on plans or schedules for automatic control. Provide a green run pilot light.

(5) Provide NEMA Class 20 resettable overload relays, accurately sized to the motor nameplate rating of the motor served and the temperature differential between motor and controller. Overloads shall be easily replaceable, and resettable without opening enclosure, via a push button or similar means. Class 10 or Class 30 overloads may be used, depending on the type of anticipated service.

(6) Provide at least one N.O. and one N.C. auxiliary contact (field-convertible to opposite operation) with each starter. Refer to mechanical details or schedules for additional requirements, if any. All starters shall have space for two additional single-pole contacts.

(7) All starters shall be thru-wiring type.

(8) Provide phase failure sensing relay to open starter coil circuit (on loss of one or more phases) on all three-phase starters controlling motors of 15 H.P. or larger.

(9) Provide power factor correction capacitors on motors of 15 H.P. or larger where predicted power factor based on manufacturer's data will fall below 0.90%. Capacitors shall be of the unit-cell type, in single enclosure with discharge resistors and tank overpressure circuit interrupter for safety.

5. REQUIREMENTS FOR WIRING

A. All wiring, including controls, interlock, miscellaneous power, sensors, thermostats, etc., shall be installed in metallic raceway systems that are in compliance with all Division 26 requirements of these Specifications, unless specifically noted otherwise. Open cabling systems will only be permitted where specifically permitted within the Division 26 Specifications and if less than 50 volts A.C. peak-to-peak or 50 volts maximum D.C.

B. Where open cabling is permitted, it shall be installed with proper support as specified in the Division 26 Specifications.

C. Where open cabling is permitted, and installed in environmental air plenum (return, relief, supply, etc.), the materials installed shall be in compliance with N.E.C. Articles 700, 725, 770 (for fiber optic), 780 and 800.

D. Where open cabling is permitted, it shall only be installed open in accessible spaces. Where concealed in walls, it shall be routed through raceways to outlet boxe(s) for the terminal device.

6. INVERTER DUTY MOTORS

A. Motors which are controlled by variable frequency drive shall be:

(1) NEMA MG-1 Part 31 rated for Inverter Duty.

(2) Furnished with shaft grounding kit for all motors:

a. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

END OF SECTION

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SECTION 23 52 00 - CONTROLS – DIRECT DIGITAL

1. GENERAL

A. The Contractor shall furnish all labor, materials, equipment and services required to provide a complete Web based temperature control system as specified and as shown on the plans. The system shall be integrated into the District's Niagara headend.

B. Prior to the installation of or payment for any work, the Contractor shall prepare submittals which shall be reviewed by the Architect and Engineer. These submittals shall include a complete control diagram and sequence of operation of the entire system, plus engineering data on all devices used.

C. The Contractor shall be a licensed installer of HVAC temperature controls by a national temperature controls manufacturer. Acceptable manufacturers are Siemens, KMC, or Honeywell. The installer shall have 5 years experience and installed a minimum of 8 systems of similar size. Their offices shall be within 100 miles of the project site.

D. The system herein specified shall be free from defects in workmanship and material under normal use and service if, within twelve (12) months from the date of acceptance by the Engineer, any of the equipment herein described is proved to be defective in workmanship or material, it will be adjusted, repaired, or replaced free of charge by the Contractor.

E. All equipment, unless specified to the contrary, shall be fully proportioning and adjustable. The Control System shall consist of all room thermostats, air stream thermostats, valves, damper operators, relays, freeze protection equipment, dampers, panels, and other accessory equipment not provided with the equipment to fill the intent of the specifications and drawings.

F. All units, controls, equipment, heat pumps, etc., and controls shall reset automatically when power is restored after an outage.

G. All control wiring concealed in walls and exposed in mechanical rooms, closets, etc., shall be in conduit. Provide plenum rated wiring where cable is concealed above ceilings. Do not paint wiring. The contractor is responsible for protecting wiring from paint. Any painted cabling shall be replaced.

H. All dampers shall be capable of operating properly with the system pressures encountered. This shall include modulating and shut-off functions.

I. The Contractor shall also refer to the mechanical maintenance, HVAC equipment, and all other sections of the specifications for additional control requirements.

J. Provide smoke detectors and shut down control for all air handling units and combined air systems as required by the MBC and IMC Section 606.

K. All DDC controllers or control modules shall have covers to protect the circuit boards. All wiring shall be anchored securely within 6" of the controller.

L. Provide all control dampers, etc. not supplied with the equipment or required to accomplish the sequences specified.

M. The Contractor shall provide all refrigeration control and interlock wiring as recommended by the equipment manufacturer.

N. Wiring and required conduit in connection with the control system(s), including power wiring of any voltage, shall be installed by the Contractor. The Contractor may, at his option, engage the Electrical Contractor to accomplish this work. It is emphasized however, that the Contractor is finally responsible for all such work.

O. Any data drops, network wiring, subnetwork hardware beyond what is indicated and provided in the contract documents is the responsibility of the temperature and controls contractor. The owner is not responsible for providing network sub structure to complete a fully functioning controls system. The controls system shall be a fully functional turn key system.

P. Electric power for the control panels, modules, unit controller, damper motors, etc., shall be derived from the building electric system. Power shall not be derived from the HVAC equipment power source or equipment low voltage transformers (internal or integral). Mechanical equipment with integral controls which are designed, listed and powered from an internal source are an exception.

Q. The electrical work required for the installation of the control system(s), shall be provided by the Contractor in accordance with all National and Local Electrical Codes. All wiring shall be concealed except in Mechanical Rooms. All electrical work specified under this division of the specifications shall also comply with the electrical specifications.

R. All exterior electrical work, equipment, etc. shall be waterproofed.

S. Controls system and all related components shall comply with ASHRAE Standard 135 (BACnet protocol).

T. This is a LEED project. Contractor shall provide cut sheets and manufacturer's product data for all thermal controls per EQ credit 6.2: Controllability of Systems, Thermal Comfort. Contractor shall provide cut sheets and manufacturer's product data for all thermal building & environmental control systems. Set point, changeover schedules, maintenance and operation instructions, and a maintenance and inspection schedule per EQ credit 7: Thermal Comfort.

2. OWNER'S TRAINING

A. The Contractor shall provide full instructions to designated personnel in the operation, maintenance, and programming of the system. The training shall be specifically oriented to the system and interfacing equipment installed. Twelve hours of Owner Training shall be provided at substantial completion, again after 6 months (four hours) and (four hours) again 1 year after substantial completion. The Owner Training shall include an overview of the entire HVAC system operation, temperature sensor setpoint manipulation, critical alarm training and graphics display overview. Subcontractors shall be present during Owner training sessions.

B. The Contractor shall provide a Sign-in Sheet and Meeting Minutes of the training. The Contractor shall also video tape the initial training sessions. Complete Operations and Maintenance Manuals shall be reviewed by the Contractor during training.

3. CONTROL SYSTEM CHECKOUT AND TESTING – BY CONTROLS CONTRACTOR PRIOR TO DEMONSTRATION AND ACCEPTANCE

A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any of all startup testing.

(1) Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 235200.
(2) Verify that control wiring is properly connected and free of shorts and ground faults.
(3) Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
(4) Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
(5) Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
(6) Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated. Submit log to Engineer for review.
(7) Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
(8) Alarms and Interlocks.
    a. Check each alarm with an appropriate signal at a value that will trip the alarm.
    b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
    c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

4. CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Control System Checkout and Testing. Provide Engineer with log documenting completion of startup tests. Submission of log is required before Demonstration and Acceptance may begin.

(1) Engineer will be present to observe and review system demonstration. Schedule with Engineer at least 14 days before system demonstration begins. Systems balancing shall be complete prior to demonstration, coordinate scheduling with TAB agency accordingly.
(2) Demonstrate actual field operation of each sequence of operation as specified in these specifications. Provide at least two persons for one day each (16 man hours) to demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Specified on site time does NOT include time necessary to correct deficiencies.
(3) Demonstrate complete operation of operator interface.
(4) Demonstrate all alarms, including external alarms to Owner selected pagers, phones, e-mail accounts, etc. Also demonstrate fire alarm system interface.
(5) Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
(6) Provide all required tools to perform system demonstration and point calibration (drills, duct plugs, thermometers, hygrometers, hand-held carbon dioxide sensors, aerosol test smoke, 2-way radios, water probes, DP sensors for water and air, etc.)

B. Acceptance.

(1) After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
(2) System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in these specifications. Warrantee will not start until acceptance by Owner and Engineer.

5. EQUIPMENT-Additionally refer to 17. AUXILIARY CONTROL DEVICES for further requirements and other equipment in this specification section.

A. CONTROL PANEL(S)

(1) Each system shall be provided with a local panel for mounting of all relays, switches, controllers, and thermometers associated with that system. Where one cabinet will not accommodate all the equipment necessary for one system, a second cabinet shall be mounted and bolted adjacent to it. Cabinets shall be provided with a 2/3's door. All devices shall be provided with lamacoid plastic nameplates for identification. Panel to be located in mechanical rooms noted on plans to have BMS headend. Additional locations or alternative locations are acceptable if coordinated in other mechanical rooms. If additional locations or other mechanical rooms are required or preferred, the temperature and controls contractor is

responsible for all power of any voltage and all network cabling, data drops, etc required in order to provide a complete fully functioning controls system.

B. THERMOSTATS

(1) General

a. All thermostats are to be provided by the temperature and controls contractor.
b. All thermostats shall have an LED display and button for warmer and cooler. This control shall allow the space occupants to reset the temperature up or down a predetermined amount. This amount or no amount at all, shall be settable thru the BAS.
c. The thermostat shall have an unoccupied override button and an integral communications port.
d. The thermostat shall have no integral thermometer.
e. All thermostats provided for the project shall be similar in size and appearance.
f. Provide tamper-proof guards for all wall mounted thermostats where shown on plans.
g. All thermostats shall be flush mounted with the wall recessed into the wall as a tamper resistant measure. Provide back boxes and utility boxes as required. Thermostat shall be designed for above-mentioned mounting style.
h. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
i. Thermostats shall provide temperature deadband of 5˚ F as required by IECC 2015.
j. **Temperature and controls contractor is responsible for providing thermostats and water source heat pump controllers that can perform the averaging function required for water source heat pumps serving two rooms.**

C. ZONE OVERRIDE PANEL

(1) Provide a password protected touch screen panel in the Admin area to allow for zones or rooms to be phased into occupied mode. The screen shall be 15” diagonal and a full color display.

D. DAMPERS

(1) Several louvers of practical widths shall be provided for larger dampers. Modulating dampers shall have opposed blades. Dampers shall have edge and end seals. Dampers shall be Ruskin CD-60 or better. Maximum leakage rate shall be 2 CFM per square foot at 1" W.G. pressure differential for dampers greater than 12" wide. Leak rate for dampers 12" and less shall be 3 CFM per square foot. NOTE: Do not mount outside air dampers so close to water coils, piping, etc., that freeze-up may occur due to a leaky damper.

E. RELAYS AND SWITCHES

(1) Relays and switches shall be of the positive and gradual acting type and shall be furnished and installed as required for the successful operation of the system. All switches shall have suitable indicating plates.

F. VALVES

(1) All valves shall be of the fully modulating and silent type unless otherwise specified. They shall provide accurate control of the heating or cooling medium under all load conditions. All valves 2-inches or smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2 inches and larger shall have iron bodies, brass or bronze trimming with flange ends. Valves shall be normally open or normally closed as required. Valves shall be installed with the stem in the upright position or as recommended by the valve manufacturer.

6. DESCRIPTION

A. General: The control system shall be as indicated on the drawings and described in the specifications.

B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.

C. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

D. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.

E. Communication between the control panels and all workstations shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.

F. The documentation is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions and sequences shown.

1. WEB BROWSER CLIENTS

(1) The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Firefox™, or Safari™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

(2) 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 FMCS, shall not be acceptable.

(3) 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.

(4) The Web browser client shall support at a minimum, the following functions:

a. 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.

b. 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.

c. 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.

d. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

e. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

(a) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

(b) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

2) Commands to start and stop binary objects shall be done by selecting the appropriate command from the pop-up menu. No entry of text shall be required.

3) View logs and charts.

4) View and acknowledge alarms.

5) Setup and execute SQL queries on log and archive information.

(5) 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.

(6) 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. ONSITE RESPONSIBILITY

A. Project Management Services: The building automation contractor shall have a project manager assigned to this project and shall attend all pre-construction and construction progress meetings. The project manager shall supervise the installation of the complete temperature control system and shall be available to the mechanical contractor to answer any questions related to the installation and operation of 100% outside air units with energy recovery, ventilation fans, Water Source VRF Systems, VAV/CAV boxes, Water Source Heat Pumps, etc, and temperature control system.

B. Owner Training Services: The building automation contractor shall provide the specified owner-training services for the controls furnished under this specification section. This contractor shall assemble representatives from all of the equipment and control device vendors and perform the owner training with their assistance. The temperature control contractor representative shall be present during all owner training of the VRV units, 100% outside air units with energy recovery, water source heat pump, VAV/CAV boxes, ventilation fans, hydronic pumping systems etc., and temperature control system.

3. QUALITY ASSURANCE

A. System Installer Qualifications

1. The Installer shall have an established working relationship with the Control System Manufacturer of not less than six years.

2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

3. The installer shall have an office within 100 miles of the project site and provide 24-hour response in the event of a customer call.

4. The list of acceptable manufacturers applies to operator workstation software, controller software, the custom application programming language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

B. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.

2. National Electrical Code -- NFPA 70.

3. Federal Communications Commission -- Part J.

4. ASHRAE/ANSI 135-1995 (BACnet)

5. EIA 901.2 (LonTalk)

C. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 5-years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.

4. SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the request.

2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.

3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.

4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior 60 seconds.

5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciation. All workstations on the network shall receive alarms within 5 seconds of each other.

9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

Table I **-- Reporting Accuracy**

Measured Variable	**Reported Accuracy**
Space temperature	±0.5°C [±1°F]
Ducted air	±1.0°C [±2°F]
Outside air	±1.0°C [±2°F]
Water temperature	±0.5°C [±1°F]
Delta-T	±0.15°C[±0.25°F]
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air pressure (space)	±3 Pa [±0.01 "W.G.]
Water pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)
Note 2: for both absolute and differential pressure
Note 3: * not including utility supplied meters

5. SUBMITTALS

Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications. An electronic copy shall be provided for review. All shop drawings shall be provided to the Owner electronically as pdf file formats.

Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the contractor from furnishing quantities required for completion.

Provide the Engineer and Owner, any additional information or data that is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.

Submit the following within 60 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
2. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
3. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
4. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each

submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:

a) Building Controllers
b) Custom Application Controllers
c) Application Specific Controllers
d) Operator Interface Computer
e) Portable Operator Workstation
f) Auxiliary Control Devices
g) Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.
h) Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
i) Points list showing all system objects, and the proposed English language object names.
j) Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.
k) Provide a BACnet Product Implementation Conformance Statement (PICS) for each BACnet device type in the submittal.
l) Color prints of proposed graphics with a list of points for display.

Project Record Documents: Upon completion of installation submit one copy of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .DWG or .DXF drawing files shall also be provided.

2. Testing and Commissioning Reports and Checklists.

3. Operating and Maintenance (O & M) Manual - These shall be as built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:

   a) Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
   b) Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
   c) Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
   d) Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

e) A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.
f) One set of electronic media containing files of all color-graphic screens created for the project.
g) A list of recommended spare parts with part numbers and supplier.
h) Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.
i) Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.
j) Licenses, Guarantee, and Warrantee documents for all equipment and systems.
k) Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) time between tasks, and task descriptions.

Training Manuals: The Contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer and shall be completed at least 3 weeks prior to first class.

6. WARRANTY

A. Warrant all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

4. The system provider shall provide a web-accessible Users Network to give the Owner access to question/answer forum, graphics library, user tips, upgrades, and training schedules.

7. OWNERSHIP OF PROPRIETARY MATERIAL

A. All project developed hardware and software shall become the property of the Owner. These include but are not limited to:
1. Project graphic images,

2. Record drawings,
3. Project database,
4. Job-specific application programming code,
5. All documentation.

8. SYSTEM SOFTWARE

1. Operating System. Furnish a commercially available, concurrent multi-tasking operating system. The operating system shall also support the use of other common software applications that operate under DOS or Microsoft Windows. The operating system shall be Windows Version 8 or newer.

2. System Graphics. The Operator Workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment. Graphics shall be capable of launching other PC applications.

a) Custom Graphics. Custom graphic files shall be created with the use of commonly available graphics packages such as PC Paint. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF and JPEG. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as Designer, AutoCAD or Revit.

b) Graphics Library. Furnish a complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library shall also include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

c) Engineering Units. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be: Standard Inch Pound.

9. SYSTEM APPLICATIONS:

Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation.

1. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any panel in the system. The storage

of this data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel.

2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database from any system panel and store on magnetic media. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

3. System Configuration. The workstation software shall provide a graphical method of configuring the system. The user with proper security shall be able to add new devices, and assign modems to devices. This shall allow for future system changes or additions.

4. On-Line Help and Training. 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. Provide an interactive tutorial CD, which will act as on-line training/help for the systems operator.

5. Security. Each operator shall be required to log on to the 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 supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's 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 logoff time shall be set per operator password. All system security data shall be stored in an encrypted format.

6. 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.

7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

    a) Alarm Reactions. The operator shall be able to determine what actions, if any, are to be taken, by object (or point), during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, texting, forwarding to an e-mail address, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. An object in alarm that has not been acknowledged within an operator specified time period shall be re-routed to an alternate operator specified alarm receipt device.

b) Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.

c) Analog Alarms. Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.

8. Trend Logs. The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. All trends shall start based on the hour. Each trend shall accommodate up to 64 system objects. The system operator with proper password shall be able to determine how many samples are stored in each trend. Trend data shall be sampled and stored on the Building Controller panel and be archived. Trend data shall be able to be viewed and printed from the operator interface software. Trends must be viewable in a text-based format or graphically. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.

9. Dynamic Graphical Charting. The operator shall be able to select system values to be charted in real time. Up to three values at one time can be selected for each chart. The type of chart (bar, line, 3-D, etc.) shall be selectable.

10. Alarm and Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. The operator shall be able to sort and filter alarms. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.

11. Object and Property Status and Control. Provide a method for the operator with proper password protection to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu, on graphics, or through custom programs.

12. Clock Synchronization. The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks; daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable.

13. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing.

Reports and logs shall be readily printed to the system printer. The operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.

a) Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

C. Workstation Applications Editors. Each PC workstation shall support full screen editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at the appropriate controller panels.

1. Controller. Provide a full screen editor for each type controller and application, that shall allow the operator with proper password to view and change the configuration, name, control parameters, and system set-points.

2. Air System Equipment Coordination. Provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations. This shall include the coordination of VAV boxes with their associated Air Handling Equipment.

3. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

a) The language shall be English language oriented and be based on the syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, the programming language can be graphically-based using function blocks as long as blocks are available that directly provide the functions listed below, and that custom or compound function blocks can be created.

b) A full screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete code from the custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

c) The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

d) The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and to observe any intermediate values and or results. The debugger shall also provide error messages for syntax and execution errors.

e) The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f) The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and xy. The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.

g) The programming language shall have pre-defined variables that represent clock time, day of the week, and date. Variables that provide interval timing shall also be available. The language shall allow for computations using these values.

h) The programming language shall have ability to pre-defined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the values of BACnet objects in the system.

10. SYSTEM SOFTWARE

A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.

B. System Security

1. User access shall be secured using individual security passwords and user names.

2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.

3. User logon/logoff attempts shall be recorded.

4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

1. Weekly Schedule. Provide separate schedules for each day of the week.

2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.

3. Holiday Schedules. Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

4. Optimal Start/Stop. The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

D. Remote Communications. The system shall have the ability to email or text alarm message. The system shall use a priority array to determine which alarms to send out and to whom.

11. BUILDING CONTROLLERS

A. General. Provide Building Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global strategies described in System software section.

2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. The controller shall provide a communications port for connection of the Portable Operators Terminal.

4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

5. Controllers that perform scheduling shall have a real time clock.

6. Data shall be shared between networked Building Controllers.

7. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

a) Assume a predetermined failure mode.
b) Generate an alarm notification.

8. BACnet. The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in these BIBBS:

DS-RP-A,B
DS-RPM-A,B
DS-WP-A,B
DS-WPM-B

B. Communications. Each Building Controller shall reside on the building wide network, which is same high-speed network as the workstations. The building wide network supports the Internet Protocol (IP). **The temperature and controls contractor is responsible for providing all additional networking beyond what is indicated on the plans to support their controls architecture. The coordination of the controls contractors additional requirements is their responsibility.** Local connections of the Building Controller shall be on ISO 8802-3 (Ethernet). Communications shall use Annex J of ASHRAE Standard 135-95. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers. Each Building Controller shall perform communications to a network of Custom Application and Application Specific Controllers using LonTalk FTT-10 and LonMark profiles or BACnet.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage

12. CUSTOM APPLICATION CONTROLLERS

A. General. Provide Custom Application Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the local strategies described in System software section.

2. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. Controllers that perform scheduling shall have a real time clock.

4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

5. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

a) Assume a predetermined failure mode.

b) Generate an alarm notification.

6. Custom application controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall be with the use of LonMark-approved SNVTs.

B. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controller used in conditioned ambient shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 0 C to 50 C [32 F to 120 F].

2. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 C to 70 C [-40 F to 158 F].

C. A local operator interface shall be provided at building locations where specified in the sequence of operations or point list. The operator interface shall be provided for interrogating and editing data. A system security password shall be available to prevent unauthorized use of the keypad and display.

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.

E. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

13. APPLICATION SPECIFIC CONTROLLERS

A. General. Application specific controllers (ASC) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

2. Each ASC will contain sufficient I/O capacity to control the target system.

B. Environment. The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 C to 65 C [-40 F to 150 F].

2. Controller used in conditioned ambient shall be mounted in NEMA 1 type rated enclosures. Controllers located where not to be disturbed by building activity (such as above ceiling grid), may be provided with plenum-rated enclosures and non-enclosed

wiring connections for plenum cabling. All controllers shall be rated for operation at 0 C to 50 C [32 F to 120 F].

C. Serviceability. Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.

D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.

E. Immunity to Power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

F. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.

G. Application Specific Controllers shall communicate using LonTalk. Controllers shall use FTT-10 transceivers. All communications shall follow LonMark profiles. ASCs which do not have a profile that applies must comply with LonMark standards, utilize SNVTs for all listed points, and be provided with a XIF file for self-documentation.

14. COMMUNICATIONS

A. This project shall comprise of a network utilizing BACnet for communications between Building Controllers and PC Workstations. LonTalk or BACnet subnetworks shall be used for communications between Building Controllers, Custom Application Controllers and Application Specific Controllers.

B. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined earlier in this section.

C. The temperature and controls contractor is required and responsible for providing all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network. The temperature controls contractor is responsible for providing a 10BaseT jack adjacent to each Building Control Panel and PC Workstation for connection to this network where not provided in plans or where required to support their proposed controls architecture.

D. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet. Building controllers shall also have a LonTalk communications port which supports FTT-10.

E. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software,

custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.

F. The time clocks in all controllers shall be automatically synchronized daily.

15. INPUT/OUTPUT INTERFACE

A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.

B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.

D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.

F. Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom programmable controllers shall have status lights, a 2-position (auto/manual) switch, and manually adjustable potentiometer for manual override.

16. AUXILIARY CONTROL DEVICES

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.

2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.

3. Damper shaft bearings shall be as recommended by manufacturer for application.

4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.

5. All leakage testing and pressure ratings will be based on AMCA Publication 500.

6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

B. Control dampers shall be parallel or opposed blade types as scheduled on drawings.

C. Electronic damper/valve actuators.

1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.

4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

5. 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 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.

6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation

8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

9. Actuators shall be Underwriters Laboratories Standard 873 listed.

10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

D. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.

2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

   a) Water Valves:
      i. Two-way: 150% of total system (pump) head.
      ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
   b) Steam Valves: 150% of operating (inlet) pressure.

3. Water Valves:

   a) Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

   b) Sizing Criteria:
      i. Two-position service: Line size.
      ii. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or [5] psi, whichever is greater.
      iii. Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), [5] psi maximum.
      iv. Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
      v. 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

   c) Water valves shall fail normally open or closed as scheduled on plans or as follows:
      i. Heating coils in air handlers - normally open.
      ii. Chilled water control valves - normally closed.
      iii. Other applications - as scheduled or as required by sequence of operation.

   d) Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

E. TEMPERATURE SENSORS

1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.

2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 feet] in length.

3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.

4. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 C [0.2 F].

F. HUMIDITY SENSORS

1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of ±5% R.H.

2. Duct sensors shall be provided with a sampling chamber.

3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% R.H. It shall be suitable for ambient conditions of -40 C to 75 C [-40 F to 170 F].

4. Humidity sensor's drift shall not exceed 1% of full scale per year.

G. STATIC PRESSURE SENSORS

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.

4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

H. LOW LIMIT THERMOSTATS

1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section.

2. Low limit shall be manual reset only.

I. FLOW SWITCHES

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.

2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 Type enclosure unless otherwise specified:

3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.

4. Current sensing relays may be used for flow sensing or terminal devices.

J. RELAYS

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.

2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

K. TRANSFORMERS and POWER SUPPLIES

1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.

3. Unit shall operate between 0 C and 50 C.

4. Unit shall be UL recognized.

L. CURRENT SWITCHES

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

M. LOCAL CONTROL PANELS

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.

2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control termination’s for field connection shall be individually identified per control drawings.

3. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

17. EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

18. GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

19. WIRING

A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ with those in Division 26, the requirements of this section shall take precedence. Also refer to section 4 of this Specification section.

B. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

C. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

D. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.

E. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

F. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.

G. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.

H. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

I. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

J. Adhere to Division 26 requirements for installation of raceway.

K. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

L. Flexible metal conduits and liquidtight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquidtight, flexible metal conduits shall be used.

M. New thermostats, sensors, etc. installed on existing wall shall be installed with concealed wiring. All thermostats are to be flush mounted or full recessed.

20. FIBER OPTIC CABLE SYSTEM

A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fibber bend radii as specified by cable manufacturer shall be maintained.

B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacture's specifications.

C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

21. INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequate for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Install duct static pressure tap with tube end facing directly down-stream of air flow.

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.

H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.

I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

22. FLOW SWITCH INSTALLATION

A. Install using a thread-o-let in steel pipe. In copper pipe use C x C x F Tee, no pipe extensions or substitutions allowed.

B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream or 2 feet whichever is greater, from fittings and other obstructions.

C. Install in accordance with manufacturers' instructions.

D. Assure correct flow direction and alignment.

E. Mount in horizontal piping - flow switch on top of the pipe.

23. ACTUATORS

A. Mount and link control damper actuators per manufacturer's instructions.

B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

D. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

24. WARNING LABELS

A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

C A U T I O N
This equipment is operating under automatic control and may start at any time without warning.

25. IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

26. CONTROLLERS

A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building level Controllers shall be BACnet/IP. Local controllers for equipment may be BACnet/mstp or LON.

C. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of [15%] spare I/O point capacity for each point type found at each location. If input points are not universal, [15%] of each type is required. If outputs are not universal, [15%] of each type is required. A minimum of one spare is required for each type of point used.

D. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

27. PROGRAMMING

A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Software Programming

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. Operators' Interface

1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the building. These standard graphics shall show all points dynamically as specified in the points list.
2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.

E. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

F. Temperature and controls contractor shall include a minimum of 32 hours of time for assisting test and balance contractor with distributive pumps, dedicated outside air, geothermal pumps, heat pumps, etc.

28. CLEANING

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

29. PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

30. FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

31. OPTINET FACILITY MONITORING SYSTEM

A. See drawings.

32. AIR QUALITY MONITORING SYSTEM

a. GENERAL

1. Drawings and general provisions of the Contract, including General Conditions of the Contract, General Conduct of the Work and Special Requirements, and Division 1 Specification Sections, apply to this Section.

b. OVERVIEW

1. This document contains the specification and input/output summaries for a Facility Monitoring System (MS). The system architecture shall utilize local room sensors, duct and outside air probes networked to distributed Air Data Routers and Sensors Suites communicating over a data and air sampling network. The air sampling network shall consist of an air packet transportation network that shall transport air samples from the environment being monitored to distributed Sensor Suites located throughout the facility. The air sampling network shall consist of intelligent air packet routers, an electrically conductive micro duct network, and structured cable. Gathering of air samples shall occur via room, duct mounted, and outside air sampling sensors and probes located as indicated in the documents. The MS shall provide continuous monitoring of environmental conditions as prescribed in the Sensor Suite section, and provide protected access via a web based user interface to analytical summaries in

onscreen and report form. The MS shall interface with other analog and microprocessor based building subsystems as shown on the drawings, specified herein and in other sections.

c. RELATED SECTIONS

1. 3rd-Party Interfacing is required on this project according to the following Specification sections for sub-systems:

    a. Section 15900 – Controls

2. REFERENCES

    a. ANSI/ASHRAE 135-2001: BACnet™ - A Data Communication Protocol for Building Automation Systems: This shall include the Standard and all published Addenda.

d. DEFINITIONS

1. MS refers to the Facility Management System. (Similar terms are: EMS, Energy Management System; BMS, Building Management System; or ATC, Automatic Temperature Control. BAS Building Automation System.)
2. FMC refers to the Facility Monitoring System Contractor. The FMC is the Contractor responsible for the implementation of this Section of the Specifications.
3. MS refers to the hardware, software and other components comprising the Facility Monitoring System as herein described.
4. I/O refers to Input/Output. Thus, "I/O device" means "Input/Output device".

e. ACCEPTABLE FACILITY MONITORING SYSTEM CONTRACTOR (FMC)

1. The FMC shall have support services within a 120 mile radius of Project Site and comply with the service requirements of a 24 hour response time. Support services is defined as having complete parts inventory, having all required test and diagnostic equipment, and have trained technicians on the systems specified herein. The Facility Monitoring System specified herein, shall be by Aircuity, Inc., Newton Massachusetts. – no other manufacturers are allowed.

f. Contractor Responsibilities:

1. The FMC shall furnish all necessary hardware, wiring, structured cable, tubing, computing equipment and software required to provide a complete and functional system necessary to perform the design intent and as defined in this specification.
2. Installation of all MS components; and all electrical work required as an integral part of this section as noted in Part 5.0 Execution including but not limited to Sensor Suites, Air Data Routers, Room Sensors, Duct Probes, Transformers,

Vacuum Pumps, Information Management Servers, Structured Cable, etc., shall be by the MS supplier.

3. The Contractor shall include in their bid price a **five year** service agreement to monitor and maintain the MS. This shall include all replacements of the sensor as well as any required maintenance or service required for the proper operation of the Sensing Suite, routers, software, etc.

g. System Requirements

1. All material and equipment used shall be standard components, regularly manufactured and available by the manufacturer and not custom designed especially for this project. All systems and components, except site specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.
2. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
3. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

h. Equipment

1. System Hardware

a. The FMC shall provide the following:

1) All Air Data Routers, Sensor Suites, Sensor Suite Sensors, Room Sensors, Duct Probes, Outside Air Probes Information Management Servers, Vacuum Pumps, Structured Cable, transformers, required to perform the functions listed.

2. System Software

a. The FMC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the FMC, including point descriptors, test sequences, reports and point summaries. The FMC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
b. The FMC shall provide a BACnet compatible integration server and software to interface with the facility's BAS.

3. Building Ethernet Connection Cabling:

a. The FMC shall provide CAT-5e or CAT-6 cabling and installation between the Information Management Server and the owner's Building Ethernet Connection. Final Building Ethernet Connection shall be coordinated with the owner's IT Group.

4. Codes and Regulations

    a. All electrical equipment and material and its installation shall conform to the current requirements of the following authorities:
        1) Occupational Safety and Health Act (OSHA)
        2) National Electric Code (NEC)
        3) National Fire Code
    b. All Air Data Routers and Sensor Suites shall be listed per:
        1) Underwriters Laboratories UL916 for Open Energy Management
    c. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

5. The control system manufacturer shall have quality control procedures for design and manufacture of facility monitoring systems for precision monitoring, indoor air quality, energy savings and preventative maintenance.
6. The FMC shall provide all test area attribute data and programming and shall coordinate object naming conventions and network map requirements with the owner's internal BAS department. The naming convention shall be submitted with the FMC Shop Drawings for review and approval by owner's BAS department.

i. SUBMITTALS

1. As soon as Submittals are prepared, an electronic version shall be provided simultaneously with the mailing of the paper copies. This version shall be transmitted in electronic format, via e-mail, to expedite the approval process.
2. Shop Drawings shall include:

    a. Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
    b. Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
    c. Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser. Riser shall include room locations and addressing for each Air Data Router and Sensor Suite. Include a Bill of Material for all equipment in this diagram but not included with the unique controlled systems.
    d. Device Addressing Scheme: Install controllers implementing an addressing scheme consistent with a reference-document. The addressing scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
    e. Equipment Numbering: Equipment numbering scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.

f. Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.
g. System Schematic: Drawings shall include a single-line representation of all areas being monitored and/or controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.
h. Point-to-point Wiring Details: Drawings shall include point-to-point wiring details and must show all field devices, routers, sensor suites, controllers, panel devices, wiring terminal numbers and any special information (i.e. shielding requirements) for properly monitoring areas and controlling equipment.
i. Bill of Material: Drawings shall include a bill of the material necessary and used for properly controlling equipment and implementing the required sequences of operation.
j. Configuration Details: Drawings shall include test and cluster sequence schedules for each test point.
k. As-Built Drawings shall be created after the final system checkout, by modifying and adding to the Shop Drawings. As-Built Drawings shall show exact installation. As-Built Drawings will be acknowledged in writing by the project design engineer and the owner's representative after the final checkout of the system. The system will not be considered complete until the As-Built Drawings have received their final approval. The FMC shall provide four sets of As-Built Drawings.

3. Operating and Maintenance Manuals

a. Operating and Maintenance (O&M) manuals for the system shall include project specific, detailed information describing the specific installation. Manual shall contain as a minimum:

1) System overview
2) Networking architecture
3) Established test sequences and cluster schedules
4) Hardware cut-sheets and product descriptions
5) Wiring diagrams for all controllers and field hardware
6) Installation, mounting and connection details for all field hardware and accessories
7) Commissioning and setup parameters for all field hardware
8) Maintenance procedures, including final tuning and calibration parameters

j. CONTRACTOR (FMC) EXPERIENCE AND PERFORMANCE

1. The FMC shall have a local office or representative, staffed with factory trained engineers, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The FMC shall be responsible for replacement of all products supplied at all times for a period of

not less than 1 year following project completion, and shall provide a 24 hour response to a service/warranty call from the owner.

k. WARRANTY

1. Repair or replace any defective product and correct any defect in material or workmanship for a period of 12 months following the date of acceptance of the system.

l. SENSOR PROPOSAL

1. A proposal shall be furnished to the owner at the time of the bid noting all annual service costs for the sensors and sensor elements to be provided within the Sensor Suite; and all costs to insure their ongoing performance. The proposal shall detail all costs for sensor element replacement, calibration services, diagnostics, software upgrades, materials and equipment necessary for ongoing sensor operation. As a minimum, twice a year, provide calibration with NIST approved calibration gases and test instrumentation, functional testing, sensor element evaluation to determine useful life and element replacement as required, and evaluation services to insure the ongoing performance of all sensors as installed system per this specification. This service shall include, but not be limited to the following:

    a. Provide a factory certified depot to remove all sensors within the sensor suite on a periodic basis (as a minimum, twice per year), and replace with pre-packaged, certified, industry traceable, factory calibrated sensors. Removed sensors shall be returned to the FMC for factory recalibration, upgrades, sensor element replacement, and component and board repairs. Written records shall be provided to the owner for every visit indicating the performance of such calibrations along with all pertinent data.
    b. All costs for the repair and replacement of any defective sensor, and for any consumable element or part on the sensor shall be included.
    c. All system software upgrades to correct bugs, fixes and patches for the sensors shall be included.
    d. Note: Refer to Part 6, Sub Section C. Proposal to be included in shop drawings for approval, cost of this shall be included in this contract.

m. AIR DATA ROUTERS

1. The Air Data Router shall be furnished as a complete, self contained, unit housing all electronics, air solenoid valves, sampling manifolds, firmware, and software. Unit shall be furnished with all internal devices and wiring assembled and tested at the factory.
2. Air Data Routers shall receive commands from the Sensor Suite to open the solenoid valve of each test area to be monitored while simultaneously closing all the other solenoid valves in the system. A direct path between the test area and the virtual

sensors located with the Sensor Suite shall be established to draw a continuous stream of air through the Structured Cable.

3. Air Data Routers shall consist of an enclosure; terminations areas for both field wiring and Structured Cable connections; a communications/processor board; high capacity solenoid valves; and sampling manifold.
4. Air Data Router shall have provisions to interface to the MS Structured Cable. Air Data Router shall utilize an internal, factory pre-assembled air sampling manifold to interface to the on-board solenoid valves, and push to connect speed fittings for ease of interface to the Structured Cable. Romex connectors and knockouts shall be factory furnished and installed on the Router.
5. Air Data Routers shall be capable of sampling of up to four test areas. Air Data Routers shall be sized and configured with the appropriate number of air sampling solenoid valves including all hardware and software to accommodate the number of test areas noted on the plans and/or specifications.
6. Air Data Router shall have the capacity to sense per test area the temperature at the room, duct or outside air via a room temperature sensor, duct probe, or outside air probe. A total of four sensor inputs shall be provided that corresponds to the air sampling of the respective four test areas.
7. Air Data router shall be capable of accepting universal 0-10v and 4-20mA inputs and outputs through expansion boards for interfacing to other third party devices and controllers.
8. Up to 30 Air Data Routers shall communicate on an isolated RS-485 network with the Sensor Suite.
9. All point data, algorithms and application software within the Air Data Routers shall be programmable from the Information Management Server. Each Air Data Router shall contain both software and firmware to receive and perform full test sequencing schemes downloaded from the Server.
10. Each Air Data Router shall contain a serial port for the interface with a portable computer. Air Data Router and network interrogation shall be possible through this port.
11. Air Data Routers shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
12. Air Data Routers shall have LED indication for visual status of communication and power.
13. Air Data Routers shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite that serves the Air Data Router. Low voltage power shall be distributed to the Air Date Routers through the associated structured cable.

n. SENSOR SUITE

1. The Sensor Suite shall be a distributed, network based, multipoint sensing device. The Sensor Suite shall be furnished as a complete, self contained unit housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.
2. The Sensor Suite shall provide communications between the Air Data Router sub network and the Information Management Server over an isolated RS-485

network. The Sensor Suite shall support communications with a sub network of 30 Air Data Routers; 30 other Sensor Suites, and an Information Management Server.

3. The Sensor Suite base unit shall consist of an enclosure; hinged door with keyed lock; terminations area for both field wiring and Structured Cable connections; a communications/processor board; electronic flow measurement and controller assembly; and sensor bay.
4. The Sensor Suite shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. As a minimum, the Sensor Suite shall be incorporate the following sensors to meet the required applications:

    a. CO2 based Demand Controlled Ventilation (DCV) or Monitoring. CO2 sensor to be Dual wavelength, non-dispersive infrared, range 0-3000 PPM; accuracy +/-75 PPM; repeatability +/- 9 PPM; response time 10 seconds.

5. The Sensor Suite shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration and service. Additional, modular sensor bay expansion capabilities shall be provided for additional sensors.
6. The Sensor Suite shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Structured Cable.
7. On-board diagnostics shall continuously perform system checks.
8. Each Sensor Suite shall contain a serial port for the interface with a portable computer. Sensor Suite and network interrogation shall be possible through this port.
9. Sensor Suites shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
10. Sensor Suites shall have LED indication for visual status of communication and power.
11. Sensor Suites shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite provided by the FMC. Transformer shall also distribute low voltage power to the Air Date Routers connected to the Sensor Suite through the associated structured cable.

o. INFORMATION MANAGEMENT SERVER

1. The Information Management Server (Server) shall provide network management of Sensor Suites, integration to the BAS, and interface to the web based Aircuity Knowledge Center for viewing and outputting graphs, charts and data derived from the Facility Monitoring System.
2. The hardware platform for the Server shall, at a minimum, consist of:

    a. PC processor with minimum 64-bit word structure.
    b. Minimum 1 GHz processor speed.

3. Minimum 256MB on board RAM
4. Hard drive or equal high-speed data storage, minimum 20 gigabytes.
5. Network Interface Card: (10/100)
6. RS-232 Serial Port
7. Operating System shall be Windows.

3. The Contractor shall provide CAT-5e or CAT-6 cabling and installation between the Information Management Server's Network Interface Card and the owner's Building Ethernet Connection.
4. The Server shall be located within 25 feet of the nearest Sensor Suite and be connected to the Server through the RS-232 serial port.

p. OT TUBING (CO2/CO Applications only)

1. The FMS shall utilize a pre-engineered system of OT Tubing to provide a low cost sampling conduit for air samples when the only contaminants of concern are either carbon dioxide (CO2) or carbon monoxide (CO).
2. OT Tubing shall be 3/8" O.D. (1/4" I.D.), dimensionally stable and shall conform to NFPA 90A flame and smoke spread indices for return air plenum installations.
3. OT Tubing shall not require any specialized tools for installation. Installation of the Tubing shall follow traditional local area network practices.
4. OT Tubing shall carry incremental length markings (in feet) throughout the Tubing length.
5. OT Tubing shall require the use of enlarger fittings (catalog number OT-E11) for all OT Tubing connections made to ADRs and duct probes. Enlarger fittings shall not be required for connecting OT Tubing to Room Sensors.
6. The minimum length of Tubing run between an ADR test area connection and an end device shall be no shorter than 20 feet.

q. ROOM SENSORS/DUCT PROBES

1. Room Sensors:
   a. A semi-flush mounted, wall plate with an integral air sampling port is to be provided; the port within the enclosure will accept the MicroDuct from the Structured Cable.
   b. Internal coarse filter to screen out large particulate from entering the MicroDuct.
   c. Terminations:
      1) Sensor – one wire
      2) Power – three wire
      3) MicroDuct – integral hose clamp
   d. Provide option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.

2. Outdoor Air Mount

a. A duct temperature sensor and air sample probe is to be mounted within one enclosure. Probe to accept integral MicroDuct from Structured Cable.
b. Internal coarse filter to screen out large particulate from entering the MicroDuct.
c. Terminations:
    1) Sensor – one wire
    2) Power – three wire
    3) MicroDuct – speed fitting
d. Provide option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.
e. Outdoor Air Locations – A NEMA 4X weatherproof enclosure shall be provided.

r. SYSTEM SOFTWARE OVERVIEW

1. The FMC shall provide all software required for operation of the MS system specified herein. All functionality described herein shall be regarded as a minimum. The FMC shall provide the following as a minimum:

    a. Completed database.
    b. Configuration of all Air Data Router, Sensor Suite, Server and user interface application programs.
    c. All Configuration Tools, and all software licenses, required to configure and operate all products installed on this project.

s. SYSTEM CONFIGURATION

1. Database Creation and Modification. All changes shall be done utilizing standard procedures. The system shall allow changes to be made either at the local site through the Information Management Server.
2. The system shall permit the operator to perform, as a minimum, the following:
    a. Add and delete points/objects
    b. Modify point parameters
    c. Create and modify control sequences and programs
    d. Reconfigure application programs

t. WEB BASED USER INTERFACE AND DATA MANAGEMENT SYSTEM

1. Included with the system shall be a fully integrated web based user interface and data management system. The data management system shall be password protected and shall be able to store sampled data from all test areas for online viewing and reporting.
2. Unlimited data access, viewing, report generation and remote data storage shall be provided with the MS for the duration of the project commissioning and for the entire warranty period.

u. TEST SEQUENCING

1. The system shall allow the operator to designate any test area to be scheduled with an operator command through the Information Management Server.
2. The operator shall be able to make all schedule additions, modifications and deletions to the test schedules. The operator shall have the capability to edit all schedules and then download any or all schedule changes to the MS.

v. EXECUTION

1. Verify that systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the MS.
2. Install software in Air Data Routers, Sensor Suites and Server. Implement all features of programs to specified requirements and as appropriate for sequence of operation.
3. Connect and configure equipment and software to achieve sequence of operation specified.

w. WIRING INSTALLATION

1. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.
2. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 26 section and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).
3. Provide wiring as required by functions as specified and as recommended by equipment manufacturer to serve specified control functions.
4. Install wiring and cables according to Division 26 section and as follows:

    a. Bundle and harness multi-conductor cable in place of single cables where several cables follow a common path.
    b. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

5. All exposed control wiring and control wiring in the mechanical, electrical, telephone, and similar rooms shall be installed in raceways. All other wiring shall be installed neatly and inconspicuously.
6. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Wiring buried in slab-on-grade

concrete or explosion-proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

x. CONTROL DEVICE INSTALLATION

1. All room sensors and shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings.

a. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.

b. Enclosures and panels mounted directly to the wall shall be provided with a minimum airspace of 1" between the enclosure and the wall.

c. A minimum of 3' working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.

d. Mounting height shall be a maximum 6'-6" to the top of the enclosure.

e. A field-installed, 14-gage galvanized steel drip shield shall be provided where enclosures and panels may be subjected to dripping water.

PART 25 - CONTROL POWER

a. Provide power for Air Data Routers, Sensor Suites, Server and associated MS components from nearest electrical control panel noted below or as indicated on the electrical drawings—coordinate with Electrical Contractor.

1. Power supply for Air Data Routers, Sensor Suites, Server and associated MS components shall be connected via a dedicated circuit to the building normal electrical distribution panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system. The temperature controls contractor is responsible for this electrical connection.

PART 26 - IDENTIFICATION

a. The FMC shall label each system device with a point address or other clearly identifiable notation inside the device cover - labels shall be permanent. All MS equipment shall be clearly identified as noted on the approved submittals.

PART 27 - ACCEPTANCE OF COMPLETED MS INSTALLATION

a. Upon completion of the installation, the FMC shall start up the system and perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed by the FMC in the presence of the design engineer, job site project manager, and owner's representative. Acceptance test shall be scheduled with at least 10 working days advance notice. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.

b. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

c. Demonstrate compliance with specifications, including calibration and testing, and air sampling test sequences. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

d. The acceptance test shall include, but not be limited to:

1. The FMC shall verify the proper operation of all input/outputs.
2. The FMC shall verify all inputs meet or exceed manufacturer's stated tolerances for accuracy.
3. The FMC shall verify that all on-line graphical displays of air sampling test data accurately represent the real time state of the field conditions.
4. The FMC shall verify the reliability of all communications of all Air Data Routers and Sensor Suites.
5. The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.

e. Acceptance: When the field test procedures have been successfully demonstrated to the design engineer, job site project manager, or owner's representative and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by the owner's representative and the warranty period shall start.

PART 28 - TRAINING

a. The FMC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.

b. Training shall include a minimum of one 8 hour session at substantial completion and another 8 hour session to be scheduled during the first year of building occupancy.

c. Instructions shall include 2 parts, the "New Equipment Orientation" and the "Product Training".

d. New Equipment Orientation: A "walk-through" session shall include showing where all field equipment is located throughout the area involved in the project.

e. Product Training: Train technical services and maintenance personnel on-site to adjust, operate, and maintain the MS. As a minimum:

1. Train personnel on procedures and schedules for starting and stopping test sequences, troubleshooting, servicing, and maintaining equipment.
2. Provide operator training on modification of data display, test area descriptors, executing commands, resetting default values, and requesting reports.

END OF SECTION

SECTION 26 05 01 - GENERAL PROVISIONS - ELECTRICAL

1. GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. The Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.

C. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating electrical systems indicated on the drawings and/or specified herein.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the electrical systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

E. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime contract, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect (if applicable), then to the Engineer.

F. This section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

G. It is the intent of this Contract to deliver to the Owner a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

H. The Contractor shall provide interim life safety and fire detection measures as required by the Authority Having Jurisdiction, Division 1 specifications, NFPA, and applicable Codes. This includes temporary relocations of heat/smoke detection, exit signage, and egress lighting in existing buildings as applicable.

I. In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Architect, Owner and Engineer (as applicable) in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without request for extra compensation to the Owner, except where otherwise provided for in the contract document.

K. Definitions:

(1) Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.

(2) Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

Note: Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

(3) Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

(4) Engineer - The Consulting Mechanical-Electrical Engineers, either consulting to the Owner, Architect, other Engineers, etc.

(5) Architect - The Architect of Record for the project, if any.

(6) Furnish - Deliver to the site in good condition.

(7) Provide - Furnish and install in complete working order.

(8) Install - Install equipment furnished by others in complete working order.

(9) Contract Documents - All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to: Plans, Specifications, Addenda, Instructions to Bidders, (both General and Sub-Contractors), Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Construction Manager's Assignments, Architect's Supplemental Instructions, Periodical Payment Requests, etc.

2. INTENT

A. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

3. ELECTRICAL DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for review before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Contractor or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. The Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.

F. The Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Special Note: Always check ceiling heights indicated on Drawings and Schedules and insure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.

H. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

I. The drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

J. The Contractor and his Sub Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.

K. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

4. EXAMINATION OF SITE AND CONDITIONS

A. The Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors or suppliers shall carefully examine all Drawings and Specifications and contract documents to determine the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.

B. The Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services,

availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. The Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility

B. References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of paragraph (A) immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten days prior to bid date for approval to bid in written form thru addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.

D. The Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

E. The Contractor shall review the contract documents and if a material substitution form is required for each proposed substitution, it shall be submitted per requirements.

6. SUPERVISION OF WORK

A. Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

7. CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.

D. All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.

E. All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.

F. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.

G. The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

8. COST BREAKDOWNS/SCHEDULE OF VALUES

A. Within thirty days after acceptance of the Contract, the Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to the end of this section for a sample of expected level and breakout being required.

9. CORRECTION PERIOD

A. All equipment, apparatus, materials, etc., shall be the best of its respective kind. The Contractor shall replace all materials at his own expense, which fail or are deemed defective as described in the General Conditions. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Architect or Engineer as being substantially complete.

B. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

10. INSPECTION, APPROVALS AND TESTS

A. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

B. The Contractor shall provide as part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services in the state of Maryland. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

C. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

D. Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

E. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

F. Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

G. The Contractor shall test all wiring and connections for cross connects, continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by continuity/load/voltage test and Megger Test the installation of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, replacing same with new and demonstrate by further test the elimination of such defect. The secondary service entrance conductors from the utility (source) transformer to the main service disconnecting means shall be megger tested. The results of this test shall be turned over to the engineer for review and approval. Any conductor failing the test shall be replaced and any costs associated shall be borne by the contractor.

11. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

12. CHANGES IN ELECTRICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

13. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. SURVEYS, MEASUREMENTS AND GRADES

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and

specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

15. TEMPORARY USE OF EQUIPMENT

A. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.

B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

16. TEMPORARY SERVICES

A. The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

17. RECORD DRAWINGS

A. The Contractor shall insure that any deviations from the design are being recorded daily or as necessary on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these record drawings electronically to the Engineer in AutoCad 2000 format (or more recent version) along with the hand marked field set. Electronic bid drawings will be furnished to the Contractor for his use at the completion of the work.

18. MATERIALS AND WORKMANSHIP

A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

B. All conduit and/or conductors shall be concealed in or below walls, floors or above ceilings unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.

C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.

D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the makers mark or name.

E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

19. QUALIFICATIONS OF WORKMEN

A. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

B. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

C. Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

20. CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

21. COOPERATION AND COORDINATION BETWEEN TRADES

A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be effected.

B. Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements.

22. PROTECTION OF EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor.

23. CONCRETE WORK

A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than l8" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish.

Special Note: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

C. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads l8" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.

D. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, trowelled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

24. RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

A. The Contractor shall restore to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable.

25. MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also see Article 1. - General, this section.

B. Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain that no utilities or lines, known or unknown, are endangered by the excavation.

C. If the above mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area. Electromagnetic utility locators and acoustic pipe locators shall be utilized to determine where metallic and non-metallic piping is buried prior to any excavation.

D. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.

E. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.

G. Protect all new or existing lines from damage by traffic, etc. during construction.

H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

26. SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

27. QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

28. FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturers representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

29. WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

30. ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.

D. Access Doors; in Ceilings or Walls:

(1) In mechanical, electrical, or service spaces:

14 gauge aluminum brushed satin finish, 1" border.

(2) In finished areas:

14 gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.

(3) In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

31. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also refer to Divisions 11, 14, 20, 21, 22, 23 and 25 of the Specifications, shop drawings and equipment schedules for additional information.

B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 and 27 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

C. Each Contractor or sub-contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

32. MOTORS

A. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box and N.E.C. required disconnecting means as indicated or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

B. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 20, 22 and 23 of the Specifications for further requirements and scheduled sizes.

C. All three-phase motors shall be tested for proper rotation. Correct wiring if needed and retest. Document testing and corrective action in operations and maintenance manual.

33. CUTTING AND PATCHING

A. Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

34. ANCHORS

A. Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

35. WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

36. OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Each Contractor shall furnish three complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

C. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

D. Formatting & content shall follow the guidelines outlined in the latest version of ASHRAE Applications Handbook, Guideline 4. As a minimum, the following shall be included:

- The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
- Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- The operating manual should contain the following information:

I. General Information
   a. Building function
   b. Building description
   c. Operating standards and logs

II. Technical Information
   a. System description
   b. Operating routines and procedures
   c. Seasonal start-up and shutdown
   d. Special procedures
   e. Basic troubleshooting

- The maintenance manual should contain the following information:

I. Equipment data sheets
   a. Operating and nameplate data
   b. Warranty

II. Maintenance program information
   a. Manufacturer's installation, operation, and maintenance instructions
   b. Spare parts information
   c. Preventive maintenance actions
   d. Schedule of actions
   e. Action description
   f. History

- Test reports document observed performance during start-up and commissioning.

37. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

38. CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to

such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

39. PAINTING

A. Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

40. INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

41. HAZARDOUS MATERIALS

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or

location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

42. ABOVE-CEILING AND FINAL PUNCH LISTS

A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:

(1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.

(2) For review of all other work as the project nears substantial completion.

B. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.

C. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of $140.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

Phone: (859) 253-0892 – Fax: (859) 231-8357

The following is CMTA's guide for required electrical information relative to the Schedule of Values. Please utilize all items that pertain to this project and add any specialized system as required. A thorough and detailed schedule of values will allow for fair and equitable Pay Application approval and minimize any discrepancies as to the status of the job.

Electrical

Description of Work	Scheduled Value	Labor	Material
Shop Drawings			
Mobilization/Permits			
Temporary Utilities			
Demolition			
Site Utilities			
Lightning Protection System Alternate			
Switchgear			
Branch Panels			
Feeder Conduit			
Branch Conduit			
Feeder Wire			
Branch Wiring			
Emergency Generator			
Fire Alarm Conduit & Wiring			
Fire Alarm Devices			

Light Fixture Interior			
Light Fixture Exterior			
Lighting Control System			
Wiring Devices			
Surge Suppression			
Chemical Grounding System			
Electrical Inspection			
Owner Training			
Record Drawings			
O & M Manuals			
Punch List / Closeout			

END OF SECTION

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SECTION 26 05 02 - SCOPE OF THE ELECTRICAL WORK

1. GENERAL

Each Electrical Contractor's attention is directed to Section 26 05 01 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

2. SCOPE OF THE ELECTRICAL WORK

The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

A. All conduits, conductors, outlet boxes, fittings, etc.

B. All switchgear, panels, disconnect switches, fuses, transformers, contactors, starters, etc.

C. Fault Current Study, Coordination Study and Arc Flash Study.

D. All wiring devices and device plates.

E. All light fixtures.

F. Emergency generator.

G. Lightning Protection System – Alternate

H. Electrical connection to all electrically operated equipment furnished and/or installed by others, including powered casework, kitchen equipment, etc.

I. Voice Evacuation fire alarm system.

J. All necessary coordination with electric utility company, etc. to insure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.

K. Paying all necessary fees and cost for permits, inspections, work by utility companies (PEPCO). The Contractor shall contact the utility companies prior to submitting a bid to determine exactly these charges will be.

L. Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid.

END OF SECTION

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SECTION 26 05 03 - SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

1. SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, seven sets of shop drawings and/or manufacturer's descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

Power Equipment

- Fault current study, coordination study and arc flash study (submit along with switchgear & panelboards).
- Switchgear and panelboards.
- Circuit breakers per each type.
- Dry-type transformers.
- Power and lighting contactors.
- Disconnect switches.
- Control components (relays, timers, selector switches, pilots, etc.)
- Building service grounding electrode components.
- Metering devices.
- Emergency generator, engine fuel system and transfer switch, with all required generator system accessories, such as battery charger, batteries, exhaust system and its insulation.
- Transient voltage surge suppression system.
- Grounding system.

Raceways

- Wireways and each type of wireway fitting.

Devices

- Each type of wiring device and their coverplates.
- Floor boxes, each by type, with required accessories.
- Any special items not listed above.

Lighting

- Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
- Lighting standards or poles.
- Photocells, time clocks or other lighting accessories.
- Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

Systems

<u>Note</u>: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Include system specific wiring schematics showing each device and its specific interconnect/wiring requirements. For rack mounted equipment,

provide a scalable elevation drawing with proposed component locations & specific interconnect wiring requirements for each component/panel. Also provide scale building specific layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.

- Voice Evacuation fire alarm system.

Miscellaneous

- Control panel assemblies.
- Non-standard junction/pullboxes.
- Manholes, hand holes, and all outdoor electrical equipment and fittings.

2. SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

3. FIRE ALARM SHOP DRAWINGS

A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to the Contractor's submittal to the governing authority for their review. No work shall be done until drawings are approved by the Authority Housing jurisdiction.

4. MAINTENANCE AND OPERATION MANUALS

A. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:

- The **operation and maintenance document directory** should provide easy access and be well organized and clearly identified.
- **Emergency information** should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- **The operating manual** should contain the following information:
  I. General Information
     a. Building function
     b. Building description

c. Operating standards and logs

II. Technical Information
a. System description
b. Operating routines and procedures
c. Seasonal start-up and shutdown
d. Special procedures
e. Basic troubleshooting

- **The maintenance manual** should contain the following information:

I. Equipment data sheets
a. Operating and nameplate data
b. Warranty

II. Maintenance program information
a. Manufacturer's installation, operation, and maintenance instructions
b. Spare parts information
c. Preventive maintenance actions
d. Schedule of actions
e. Action description
f. History

- **Test reports** document observed performance during start-up and commissioning.

END OF SECTION

SECTION 26 05 04 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

A. The Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. He shall determine and coordinate any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, buss duct, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Architect. Any damage caused to the building by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

C. The Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

D. The Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

E. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

F. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

G. In all cases, sleeves shall be at least two inches larger than nominal pipe diameter.

H. Sleeves passing through roof or exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. Any roof penetration shall not void or lessen the warranty in any way.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

J. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Architect.

K. The Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Architect.

L. All work improperly done or not done at all as required by the Contractor will be performed by others. The cost of this work shall be paid for by the Contractor who is in non-compliance with the Contract.

2. SLEEVES, PLATES AND ESCUTCHEONS

A. The Contractor shall provide and locate all sleeves required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for conduits where sleeves were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the conduit and the sleeves shall be made completely and permanently water tight.

B. Conduits that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

C. At all other locations either pipe sleeves or core drilled openings are acceptable.

D. Where thermal expansion does not occur, the wall may be sealed tight to the conduit.

E. Sleeves shall be constructed of rigid steel conduit. Sleeves in floors shall extend 6" above finished floor level.

F. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

G. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.

H. Escutcheon plates shall be provided for all conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the sleeves.

END OF SECTION

SECTION 26 05 06 - LIGHTNING PROTECTION SYSTEM

1. GENERAL

   A. Each Electrical Contractor's attention is directed to Section 260501, General Provisions - Electrical and all other contract documents as they may apply to his work.

   B. Include as part of Alternate pricing.

2. SCOPE OF THE WORK

   A. The Electrical Contractor shall provide the necessary labor, materials, services necessary to provide the complete lightning protection system as specified herein. This work shall include, but is not necessarily limited to:

      Conductors
      Air Terminals
      Connectors
      Splicers
      Ground Rods
      Rod Clamps
      Ground Plates
      Bonding Plates
      Surge Arrestors

3. QUALITY ASSURANCE

   A. Manufacturers: First regularly engaged in manufacturer of lightning protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than 5 years. The firm shall be a member of and certified by the Lightning Protection Institute of America.

   B. Installer: A firm with at least 3 years of success installation experience on projects with lightning protection work similar to that required for project.

   C. ANSI/NFPA Compliance: Comply with NEC and NFPA No. 780, "Standard for the Installation of Lightning Protection Systems", as applicable to materials and installation of lightning protection components and wiring.

   D. ANSI Compliance: Comply with applicable portions of ANSI C2 and C62.2 pertaining to lightning (surge) arrestors.

   E. UL Compliance: Comply with UL 96, "The Standard for Lightning Protection Components" and UL96A, "Installation Requirements for Lightning Protection Systems" pertaining to design, materials and sizing of lightning protection components. Provide components which are UL listed and labeled.

4. SUBMITTALS

A. Product Data: Submit manufacturer's data on lightning protection systems and components.

B. Shop Drawings: Submit dimensioned layout drawings of lightning protection system equipment and components including conductor routing and connections.

C. Maintenance Data: Submit maintenance instructions for lightning protection system. Include this data in maintenance manuals.

D. UL Certificate: Provide Owner with UL Master "C" Label for new buildings overall system which is suitable for fastening to building for display. Comply with UL 96A. "Master Labeled Lightning Protection Systems".

5. MATERIALS

A. Acceptable Manufacturers

Available Manufacturers: Subject to compliance with requirements, manufacturers offering lightning protection components which may be incorporated in the work include, but are not limited to, the following:

Conductors and Air Terminals:

Independent Protection Co., Inc.
Thompson Lightning Protection, Inc.
A/C Lightning Protection Co., Inc.

Protective Devices (Surge Arrestors):

General Electric Co.
TII Industries, Inc.
Atlantic Scientific Corp.

6. LIGHTNING PROTECTION SYSTEM COMPONENTS

A. General

(1) Provide lightning protection system components of types, sizes, ratings for class of service indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information and as required for a complete installation. Where more than one type of component meets requirements, selection is Installer's option. Where type or material is not otherwise indicated comply with NFPA 780 and UL 96 standards.

B. Conductors

Class 1 Installations:

(1) Main Conductors: Aluminum cable; strand dia. 0.064"; 0.095#/ft.; 98,600 circular mils.

(2) Secondary Conductors: Aluminum cable; strand dia. 0.064"; 10 strands.

(3) Air Terminals: Aluminum for concealed installation; 10" point, 1/2" x 12" long solid aluminum stem, lead washer, support bracket and adjustable clamp type cable connector.

(4) Connector: Aluminum right-angle thru-roof cable connector; bronze and lead seal flashing washer, 1/2" x 8" threaded stem, to fit 6" roof thickness.

(5) Connector: 4" aluminum parallel bonding clamp for connecting 1/0 or 2/0 cables.

(6) Splicer: Aluminum straight cable splicer for splicing No. 4 and No. 6 cables.

(7) Splicer: Aluminum pressure type "T" cable splicer for clamping standard cables through 2/0 with hex bolts and washers.

(8) Splicer: Bimetal straight splicer of cast aluminum and bronze for 2/0 cable with moisture tight sealing capability.

(9) Ground Rod: Solid copper, 5/8" dia. x 10'.

(10) Rod Clamp: 4" bronze ground rod clamp for connecting cable, up to and including 2/0 and 5/8" or 3/4" ground rod.

(11) Ground Plate: Sheet copper plate, 36" x 36" x 20-gauge, with 2 cable attachments.

(12) Bonding Plate: 8 sq. in. steel plate with 1" dia. bolt-hole for bonding cable to structural steel, with vice-grip type cable connector with 2" of cable contact.

(13) Surge Arrestor: Electrical service arrestor, solid state, 277/480V/3ϕ/4W for exterior mounting.

7. EXECUTION - Installation of Lightning Protection Systems

A. Install lightning protection systems as indicated in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA No. 70 and 780 and with UL's lightning protection standards to ensure that lightning protection systems comply with requirements.

B. Coordinate with other work, including electrical wiring and roofing work as necessary to interface installation of lightning protection system with other work.

C. Install conductors with direct paths from air terminals to ground connections avoiding sharp bends and narrow loops.

D. Install arrestors as close as practical to equipment they are protecting. Install appropriate unit at main electrical service entrance equipment.

8. TESTING

A. Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional ground rods. Provide to the Owner and the Engineer a certificate of compliance upon completion of testing.

END OF SECTION

SECTION 26 05 08 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

   A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing, Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

   B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

   C. The Contractor shall be responsible for coordination with all trades to insure that they have made provision for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc., that are required for equipment operation shall be provided as a part of this contract.

   D. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

   E. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Architect and Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Architect or Engineer where in doubt about the potential acceptability of an installation.

2. INTERFACING

   Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall insure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

A. Connection of Power lines to Owner's existing or new services.

B. Connection of fuel oil and exhaust piping to emergency generator and furnishing of fuel for testing unit. Provide a full tank at final acceptance.

C. Connection of all controls to equipment.

D. Electrical power connections to electrically operated (or controlled) equipment.

E. Electrical provisions for all equipment provided by other trades or suppliers within this contract.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

END OF SECTION

SECTION 26 05 19 - CONDUCTORS, IDENTIFICATION, SPLICING DEVICES & CONNECTORS

1. GENERAL

   A. This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include communications, data or signal system conductors, which are specified separately in these specifications.

   B. All conduits installed without conductors shall have a 200 lb. test nylon string installed for future use, tied off securely at each end.

   C. **No more than 40% conduit fill is permitted for <u>any</u> conduit system, including video, intercom, data, power or other signal circuits unless specifically indicated otherwise on the plans.**

   D. Lighting circuits: No more than five conductors shall be installed in conduit except for switch legs and travelers in multi-point switching arrangements.

   E. Receptacle circuits: If multiple circuits are pulled in a single homerun, a dedicated neutral shall be provided for each phase conductor. In these cases, a maximum of seven conductors are permitted in a single conduit. Conductors shall be derated per N.E.C.

   F. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

2. MATERIALS

   A. CONDUCTORS

      (1) All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled.

      (2) Lighting and receptacle branch circuits shall be not less than No. 12 copper wire or of the sizes shown on the drawings with Type THW, THHN or THWN insulation. All feeder circuits shall be Type THW or THWN of the size as shown on the Contract Drawings. THHN wiring shall only be installed in overhead, dry or damp locations. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.

      (3) Conductors No. 10 and smaller sizes of wire shall be solid. Conductors No. 8 and larger sizes shall be stranded.

(4) Conductors for fire alarm wiring shall be stranded and in full compliance with N.E.C. 760. All fire alarm conductors shall be installed within conduit and enclosed junction boxes.

(5) All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.

(6) The color of the wire shall be selected to conform with Section 210-5 of the latest edition of the National Electrical Code. Refer also to 260519-4, Color Coding.

(7) All equipment grounding conductors shall have green color insulation or if larger than #8, shall be taped for two inches, green color at every termination and pullbox access point.

(8) Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.

(9) Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper.

(10) All conductors shall be identified by color code and by means of labels placed on conductors in all junction boxes and at each terminal point with Brady, Ideal, T & B or approved equivalent labels indicating source, circuit No. or terminal No.

(11) Branch wiring and feeder conductors that are greater than 100' in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop. As calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

(12) No aluminum conductors shall be used.

B. SPLICING DEVICES & CONNECTORS

(1) Splicing devices for use on No. 14 to No. 10 AWG conductors shall be pressure type such as T & B "STA-KON", Burndy, Reliable or approved equivalent.

(2) Wire nuts shall be spring pressure type, insulation 600V, 105°C insulation, up to #8 size. Greater than #6 Cu shall be a compression type connection, 600V insulation, cold shrink tubing, taped to restore full insulation value of the wire being spliced.

(3) Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using No. 10 AWG or smaller conductors.

(4) Splices, where necessary, shall be made with hydraulically-set "Hy-press" or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.

(5) Large connectors (lugs) at terminals shall be mechanical type, hex-head socket or crimp-on style, installed per the manufacturer's recommendations.

(6) Exterior underground connections made between bare ground wires or to ground rods shall be exothermically welded, "Cadweld" or equivalent.

(7) The use of split-bolt clamps will be permitted in wireways at service entrance only. Torque to 55 foot-pounds or as recommended by manufacturer.

3. INSTALLATION

A. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

B. The radius of bending of conductors shall be not less than eighteen times the outside diameter of the conductor insulation or more, if recommended by the manufacturer.

C. Conductors installed within environmental air plenums shall be per N.E.C. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Also provide plenum-rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.

D. Where indicated, communications conductors that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the access to or operation of equipment or removal of ceiling tiles. Tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans. Refer to the drawings for support requirements and details on routing exposed communications conductors.

E. Conductors for isolated power systems shall be installed in as short a run of conduit as practicable. No pulling soap shall be used on conductors in isolated power systems.

F. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment as required to ensure compliance. Use particular caution when installing twisted pair data cable or fiber optic cables -- forces permitted for pulling in are typically very low for these cable types.

G. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 6 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical,

provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.

H. Where multiwire branch circuits are allowed, the phases and neutral shall be wire-tied together in the panelboard and in all pull boxes.

4. COLOR CODING DISTRIBUTION VOLTAGE CONDUCTORS, 600 VOLT OR LESS

A. Conductors to be color coded as follows:

(1) 120/208 Volt Conductors
Phase A - Black
Phase B - Red
Phase C - Blue
Neutral - Solid White or White with tracer stripe to match phase conductor

(2) 277/480 Volt Conductors
Phase A - Brown
Phase B - Orange
Phase C - Yellow
Neutral – Solid Gray or White with tracer stripe to match phase conductor

Note: Further identify isolated power conductors with " wide purple tape at all terminations and junctions.

(3) Control Wiring - Red, or as indicated.

(4) Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.

(5) D.C. Wiring - Positive - Light Blue
Negative - Dark Blue

END OF SECTION

SECTION 26 05 26 - GROUNDING

1. GENERAL

   A. All metallic conduit, raceways, cable trays, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest issue of the National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.

   B. The size of the equipment grounding conductors, grounding electrode conductors and service grounding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings. Where ungrounded conductor sizes are increased to minimize voltage drop, grounded conductor sizes shall be increased in the proper proportion.

   C. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.

   D. The service entrance main ground bus shall also be connected to the main cold metallic water pipe within three feet of where it enters the building, on both the house and street sides of the main shut-off valve with a properly sized bonding jumper. A properly sized bonding jumper shall also be provided to the frame of any steel structure utilized in the construction. The steel frame of the building (if any) shall be made electrically continuous.

2. MATERIALS

   A. Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accord with the prevailing codes. All ground wires and cables shall be copper.

   B. All grounding fittings shall be heavy cast bronze or copper of the mechanical type except for underground installations or interconnection of grounding grid to cable, columns and ground electrodes, which shall be thermically welded type as manufactured by Cadweld, Burndy Co., Therm-O-Weld, or approved equivalent. Other bonding clamps or fittings in above ground locations shall be as manufactured by O.A. Co., T & B, Burndy, or approved equivalent.

   C. Ground electrode pipe systems shall be solid copper construction. Ground rods shall be 5/8" minimum diameter, eight feet long, copperweld steel. All ground electrode systems shall be installed in accord with manufacturer's recommendations, U.L. listings, National Electrical and National Electrical Safety Codes.

3. INSTALLATION

   A. All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through flexible conduit and through panelboard switchboard or motor control center feeders, they shall be securely bonded to such conduit thru the use of grounding bushings at the entrance and exit. All connection of equipment shall be

made with an approved type of solderless connection and same shall be bolted or clamped to equipment or conduit.

B. All equipment grounding conductors to lighting fixtures, devices, receptacles, electric heaters, furnace and other equipment not exceeding No. 8 AWG in size shall be green colored Type "THWN".

C. Equipment ground connections to GFI circuit breakers shall be carried and bonded to each outlet on the circuit. Provide a separate equipment grounding conductor with green color insulation.

D. Resistance to the grounding at the service entrance equipment shall be in accordance with the N.E.C. for style of construction and shall not exceed ten ohms as measured by the described testing method.

E. All circuits shall have a separate grounding conductor, except as otherwise noted.

F. When grounding systems are completely installed and all grading in the area of the service grounding electrode has been completed up to finish elevations, perform a fall-of potential or other approved test to determine actual system resistance to earth. Report results to the Engineer in writing. Refer to testing provisions in this section of specifications.

G. The Contractor shall ensure that the ground return path thru building structural steel or other means is electrically continuous back to the service grounding electrode and is of adequate capacity and impedance to carry the maximum expected fault or other current. Where no electrically continuous steel building frame is available, the Contractor shall provide a properly sized ground bar and ground conductor routed back to the main facility ground bus.

H. Where a building's steel frame is made electrically discontinuous by masonry breaks (as at firewalls, etc.), the Contractor shall provide an accessible thermically welded bonding jumper of #500MCM copper to bond the building steel frame sections together, making the entire steel frame electrically continuous. The installation of these bonding jumpers shall be reviewed by the Engineer prior to their being covered by construction.

I. Grounding connections shall **never** be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.

J. Where dielectric fittings are utilized in piping systems, the piping system shall **not** be utilized as a ground path. Bonding jumpers shall not be utilized to bridge over such fittings. Piping systems shall not be utilized as ground paths except where specifically required by codes in the case of water piping.

4. GROUNDING ELECTRODE SYSTEM

A. The ground electrode system shall be as specified herein. The system shall not require maintenance throughout the expected life span of the materials.

B. Ground system shall be an electrolytic rod type, as manufactured by Lyncole XIT Grounding, Superior Grounding Systems, L.E.C., Inc. (Chem-Rod), or approved equivalent. Electrode(s) shall be placed as shown on the plans, installed exactly per manufacturer's recommendations. Electrodes shall be installed vertically, 12 feet of overall length (or length as indicated), set in a drilled hole and backfilled per manufacturer's instructions with a special clay slurry surrounding the rod. Provide a concrete protection box with cast iron grate for the top of the rod termination. Ground system shall be per the following:

(1) Manufacturer: Lyncole XIT Grounding (or approved equivalent).
(2) Source: Lyncole XIT Grounding, 22412 S. Normandie Ave., Torrance, CA 90502 1-800-962-2610
(3) Shaft Configuration: Straight.
(4) Shaft Length: 12 feet (or as otherwise indicated).
(5) Listings: U.L.-467J, ANSI 633.8.
(6) Material: Type K Copper.
(7) Construction: Hollow tube, 2.125" O.D., chemical filled with non-hazardous metallic salts.
(8) Weight 3.5 lbs. per foot of length, nominal.
(9) Ground Wire Termination: Exothermic ("Cadweld" by Contractor) connection to 4/0 conductor, with U-bolt with pressure plate provided as test point.
(10) Average Life Expectancy: 25 Years.
(11) Model Number: K2-(length)CS.
(12) Provide grounding system with the following components: protective box, backfill material. Box to be concrete with cast iron, tamper-resistant lid, backfill to be "Bentonite" clay.

C. Installation of Pipe Ground System

(1) **Pipe ground systems shall be installed exactly as required by the system manufacturer. The Contractor shall be diligent to observe the excavation, sealing tape removal, slurry backfill and all other critical requirements.**

(2) **Note: <u>NEVER</u> USE SAND OR ORDINARY EARTH AS A BACKFILL MATERIAL**

D. Pipe grounding system shall be warranted unconditionally by the Contractor for a period of one year from the date of substantial completion.

5. GROUND TESTING PROCEDURE

A. The actual resistance to earth of the service grounding electrode shall be measured by the Contractor via the fall-of-potential method. This testing shall be accomplished after the grounding electrode has been completely installed and the finished grade is achieved.

B. The results of the testing shall be summarized in a written report by the Contractor, which shall be forwarded to the Engineer for review. The report shall also be included with the operation and maintenance manuals for the Owner's information and future reference. This report is to also contain a detailed description and illustrations of the testing procedure, along with the name and model number of the testing instrument(s).

C. For the actual testing, the Contractor shall follow the procedures outlined below. A self-contained instrument such as a "Megger" or "Ground OHMMETER" shall be used that is designed to eliminate the influence of stray current effects on the accuracy of the measurements.

(1) Connect one side of the instrument to the grounding electrode conductor where it connects to the facility main ground bus (point C1). Disconnect and isolate the grounding electrode conductor for the test.

(2) Drive a copperweld reference electrode probe (point C2) into earth between 300 and 500 feet away from C1 and connect to measurement instrument.

(3) Drive the movable grounding probe (C3) into earth at ten equally spaced intervals, in a straight line between C1 and C2 points and note the E/I=R resistance readings on a graph at each point.

(4) The resistance measurements in OHMS taken from the flat part of the curve shall be averaged to determine the true grounding electrode resistance to earth.

(5) At completion of testing, remove reference electrode C2 and all temporary wiring and connections.

(6) If actual measurements of grounding electrode indicate a resistance greater than five OHMS, contact the Engineer for instructions. If deemed necessary by the Engineer, additional electrodes shall be placed and the measurement process repeated until the desired ground potential achieved.

END OF SECTION

SECTION 26 05 31 - CABINETS, OUTLET BOXES AND PULL BOXES

1. GENERAL

   A. This section of the specifications covers all electrical cabinets, outlet boxes and pull boxes.

   B. Continuous runs of conduit shall have properly sized pull boxes at least each eighty-five feet of run, or as near as possible to that limit.

2. MATERIALS & INSTALLATION

   A. Cabinets, Outlet and Pull Boxes:

      (1) Cabinets for lighting and power, telephone, pull boxes, outlet boxes, or any other purposes specified or shown on the Contract Drawings, shall be constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing. Boxes assembled with sheet metal screws will not be accepted. Pull boxes shall include all boxes used to reduce the run of conduit to the required number of feet or bends, supports, taps, troughs, and similar applications and shall also be constructed as specified above.

      (2) All cabinets and boxes for NEMA 1 and 1A application shall be provided with knockouts, as necessary, or shall be cut in the field by approved cutting tools which will provide a clean, symmetrically cut opening. All boxes, except panelboards, shall be provided with code gauge fronts with hex head or pan head screw fasteners. Outdoor cabinets shall be hinged cover with pad locking provisions. Fronts for panelboards shall be as specified for panelboards.

      (3) Ceiling outlet boxes shall be galvanized steel, 4" octagonal, not less than 2 1/8" deep, with lugs or ears to secure covers. Those for use with ceiling lighting fixtures shall be fitted with 3/8" fixture studs fastened to the back of the boxes, where applicable. Provide adequate support with at least a 2 x safety factor for the anticipated fixture weight.

      (4) Special size concealed outlet boxes for clocks, speakers, alarms, panels, etc., shall be provided by the manufacturer of the equipment.

      (5) Floor outlet boxes shall be as specified in Section 262726, fully adjustable unless noted or specified otherwise.

      (6) Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to centerline of box:

      Wall Switches, Control Stations .....3'-10"
      Convenience Outlets .....1'-6"
      Convenience Outlets - Above Counters.....Bottom at 2" above top of backsplash
      T.V. Outlet receptacle - At Wall Brackets .....refer to AV drawings and electrical legend
      Weatherproof Outlets .....2'-2"
      Disconnects, Branch Panelboards .....5'-0" max. to centerline

Fire Alarm Manual Stations .....3'-10"
Fire Alarm Audio and/or Visual Units80" AFF to bottom of device or 6" below ceiling, whichever is lower.

(7) The location of outlets, as shown on the drawings, shall be considered as approximate only. It shall be incumbent upon this Contractor to study the general building drawings, with relation to spaces surrounding each outlet, in order to make his work fit the work of others and in order that when the devices or fixtures are installed, they will be symmetrically located and will not interfere with any other work or equipment. Any change in fixture or layout shall be coordinated with and approved by the Engineer before this change is made. Regardless of the orientation shown on the drawings, all devices shall be easily accessible when installed.

(8) Boxes installed in fire rated assemblies shall not compromise the rating of the assembly. The Contractor is responsible for identifying assembly ratings and construction requirements prior to rough-in.

a. Listed single and double gang metallic outlet and switch boxes with metallic or nonmetallic cover plates may be used in bearing and nonbearing wood stud and steel stud walls with rating not exceeding 2 h. The boxes shall be fastened to the studs with the openings in the wallboard facing cut so that the clearance between the boxes and the wallboard do not exceed 1/8 in. The boxes shall be installed so that the surface area of individual boxes do not exceed 16 sq in, and the aggregate surface area of the boxes do not exceed 100 sq in per 100 sq ft of wall surface unless approved alternate protection materials are used.

b. Boxes located on opposite sides of walls or partitions shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between the boxes may be reduced when listed Wall Opening Protective Materials are installed according to the requirements of their Classification.

c. Boxes installed on opposite sides of walls or partitions of staggered stud construction shall have listed Wall Opening Protective Materials installed with the boxes in accordance with Classification requirements for the protective materials.

d. All installation shall be done in accordance with AHJ requirements.

(9) All outlets, pull boxes, junction boxes, cabinets, etc., shall be sized per the current edition of the National Electrical Code.

B. Cabinets, outlet boxes and junction or pull boxes shall be threaded for rigid-threaded conduit, dust-tight, vapor-tight or weatherproof as required for areas other than for NEMA 1 or 1A application. These shall be as manufactured by Crouse-Hinds, Appleton, Killark, or approved equivalent.

(1) NEMA 1 or 1A cabinets, outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent.

(2) Outlet boxes for switches, receptacles, telephone, etc., concealed in walls shall be galvanized steel, 2" X 4" X 2" with plaster cover for the number of devices as required. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry which will not be covered with plaster or in walls covered by wood wainscot or paneling, deep sectional masonry boxes shall be used and they shall be completely covered with the plates or lighting fixtures. This Contractor shall cooperate with the brick layers, block layers and carpenters to insure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls, unless noted otherwise.

(3) Outlet boxes mounted in glazed tile, brick, concrete block or other types of masonry walls shall be mounted above or below the mortar joint. Do Not Split The Mortar Joint.

(4) Boxes for more than two devices shall be for the number of devices required and shall be one piece. No ganging of single switch boxes will be allowed.

(5) Outlets provided shall have only the holes necessary to accommodate the conduit at the point of installation and shall be rigidly secure in position. Boxes with knockouts removed and openings not used shall be replaced or be provided with a listed knockout closure.

(6) Openings for conduit entrance in cabinets and boxes shall be prefabricated, punched, drilled and/or reamed. The use of a cutting torch for this purpose is prohibited.

END OF SECTION

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SECTION 26 05 33 - RACEWAYS & FITTINGS

1. GENERAL

A. This section is intended to specify the raceways, conduit, conduit fittings, hangers, junction boxes, splice boxes, specialties and related items necessary to complete the work as shown on the drawings and specified herein.

B. This section specifies basic materials and methods and is a part of each Division 26, 27 and 28 that implies or refers to electrical raceways specified therein.

C. The types of raceways specified in this section include the following:

(1) Steel electrical metallic tubing. (E.M.T.)
(2) Rigid galvanized steel conduit. (G.R.S.)
(3) Intermediate metal conduit (I.M.C.).
(4) Rigid aluminum conduit.
(5) Flexible metal conduit (aluminum or steel)
(6) Liquid - tight flexible metal conduit.
(7) Rigid nonmetallic conduit.
(8) Cable tray or cable trough.
(9) Duct banks, and their construction.

D. All raceways, as listed in 1C. above and otherwise specified herein shall be provided in compliance with latest editions of all applicable U.L., NEMA, N.E.C. and A.N.S.I. standards. All conduit, raceways and fittings shall be Underwriters Laboratories listed and labeled, or bear the listing of an agency acceptable to the local authority having jurisdiction.

E. Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all A.C.I. standards and the equipment manufacturer's recommendations for such work.

F. P.V.C. or other non-metallic conduit shall be rated for the maximum operating temperature that could be developed by the conductors it encloses, while in normal operation.

G. The decision of the Engineer shall be final and binding in any case where a question or inquiry arises regarding the suitability of a particular installation or application of raceways, supports or materials, if other than outlined herein.

H. Minimum size of conduit shall be 3/4" trade size. All conduit and raceways shall be sized for the number of conductors contained, in accord with the latest edition of the National Electrical Code or any other applicable standards.

I. The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

2. MATERIALS

A. STEEL ELECTRICAL METALLIC TUBING

(1) Electrical metallic tubing, (E.M.T.) of corrosion-resistant steel construction shall be permitted for concealed installation in dry interior locations. Electrical metallic tubing shall not be installed in concrete slabs or where exposed to physical damage. Electrical metallic tubing shall be permitted for exposed work in mechanical and electrical rooms and other exposed structure areas where not subjected to physical damage, as determined by the Engineer.

B. RIGID GALVANIZED STEEL CONDUIT

(1) Rigid galvanized steel conduit shall be used where subject to physical damage for exposed work in mechanical spaces, within factory or other industrial work areas, for exposed fit-up work on machinery, for exposed exterior damp or wet location work, in hazardous atmospheres, in exterior underground locations where installed beneath roadways, where ells occur in underground P.V.C. conduits, or where turning out of concrete encased duct banks, and at other locations as specifically called out on the drawings.

(2) Rigid galvanized steel conduit shall be used for all building interior power wiring or cables of over 600 Volts.

C. INTERMEDIATE METAL CONDUIT

(1) Unless otherwise indicated on the drawings, intermediate metal conduit (I.M.C.) may be used in any location in place of rigid galvanized steel conduit, as permitted by codes, and as approved by the Engineer.

D. RIGID ALUMINUM CONDUIT

(1) Rigid aluminum conduit, shall be permitted for installation indoors in dry locations only. Under no conditions shall it be cast into concrete slabs or pass thru construction where prolonged contact will degrade the aluminum. All ells used in rigid aluminum conduit systems shall be rigid galvanized steel. Rigid aluminum conduit shall always be used for power wiring greater than 5 KVA and higher than 60 Hz frequency.

E. FLEXIBLE METAL CONDUIT

(1) Flexible conduit shall be used where permitted by NEC. It may be constructed of aluminum or steel. It shall be installed with connectors designed for the purpose. All flexible metal conduit shall be installed as a single piece. No joints shall be installed. Flexible conduit shall not be used in wet or dusty locations or where exposed to oil, water or other damaging environments. An equipment grounding conductor or bonding jumper shall be used at all flexible conduit installations. Maximum permitted length of flexible metal conduit shall be 72", as for light fixture whips unless approved in writing by Engineer.

F. LIQUIDTIGHT FLEXIBLE METAL CONDUIT

(1) Weatherproof flexible metal conduit shall be wound from a single strip of steel, neoprene covered, equivalent to "Liquatite" or "Sealtite" Type "UA". It shall be installed in such a manner that it will not tend to pull away from the connectors. Provide strain relief fittings equivalent to "Kellems" as required where subject to vibration. Flexible connections to motors in dusty areas shall be dust-tight, in areas exposed to the weather - weatherproof.

G. RIGID NON-METALLIC CONDUIT

(1) Rigid non metallic conduit shall be constructed of P.V.C, nominally schedule 40 weight, except where encased in concrete, where it may be "EB" type. If installation will enclose utility company provided conductors, verify exact type required and install in accord with their standards, if more stringent than this specification.

(2) Rigid non-metallic conduit may be used in exterior wet or damp locations where installed underslab or underground. It shall not be run in interior locations, except with special permission from the Engineer for use in corrosive environments, and then only if protected from physical damage. No rigid nonmetallic conduit may be installed in environmental air plenums or cast into above-grade concrete slabs. No rigid nonmetallic conduit may be installed in locations where the ambient temperature might exceed the rating of the raceway.

(3) Where rigid non metallic conduit is placed underground, as for feeder circuits, secondaries or branch circuit runs and where ell is made upward thru a slab on grade, transition the turning ell and the riser to rigid steel conduit to a height of 6" above the concrete slab. Transition may then be made to E.M.T or other approved conduit for remainder of run.

(4) Flexible nonmetallic conduit shall not be used, except by special permission, obtained in writing from the Engineer.

(5) Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.

H. DUCT BANKS

(1) Duct banks are defined as a raceway or raceways installed in underground locations, enclosed in a steel-reinforced concrete envelope. They shall be installed where indicated on the drawings or otherwise required.

(2) All concrete used in duct bank construction shall be 3000 PSI minimum 28 day compressive strength unless otherwise noted, in accord with latest A.C.I. standards. Testing of concrete shall be the responsibility of the Contractor, as directed by the engineer. Place concrete against undisturbed earth, or provide forming as needed.

(3) Duct bank raceways shall receive a minimum of 3" concrete cover all sides. Minimum size of any duct bank shall be 12" x 12" square, in cross section. In all cases, local and national codes shall apply to duct bank construction where they exceed the requirements of this specification.

(4) Each corner of duct bank shall receive a minimum No. 4 steel reinforcing bar with 2" minimum concrete cover on all sides. Lap bars fifteen diameters at all splices. Provide stirrup bars bury 60" on center to tie bars together. Stirrups may be #3 bar. Reinforcing steel shall be rigidly supported during pour and vibration, and shall be constructed to ASTM standards.

(5) Support for encased raceways shall be as recommended by raceway manufacturer, spaced 8'-0" maximum on centers, rigidly fastened to prevent floating of ducts during concrete pours. Supports shall be of a material compatible with the raceway, and shall be of the interlocking type, forming a rigidly braced installation. Provide base type and intermediate type spacers to suit conduit configurations and sizes.

(6) Where rigid nonmetallic raceways leave concrete duct banks, a transition to rigid steel conduit shall be made 18" inside the concrete envelope. Under no circumstances shall PVC, EB or similar ducts exit concrete envelope, except where duct bank ties into a manhole wall. Provide bell ends at such terminations and dowel duct bank rebars 4" into manhole wall with non-shrink grout. Refer to details on drawings, as applicable. Slope all raceways within duct bank systems such that they shall drain into manholes or pull boxes. Provide proper drainage at manholes or pull boxes to prevent water accumulation.

(7) Where ducts transition thru manholes, pull boxes or at terminating end, each duct shall be specifically identified. A nomenclature as shown on the drawings or as agreed upon by the installer and engineer shall be utilized to identify each individual duct. A permanent means of identifying each duct, such as engraved lamacoid plates or stamped metal tags shall be used.

I. RACEWAY FITTINGS

(1) Raceway fittings (or condulets) shall be of gray iron, malleable iron or heavy copper-free cast aluminum. They shall be furnished in proper configurations, avoiding excessive plugged openings. Any openings that are left shall be properly plugged. All coverplates shall be gasketed with neoprene or similar approved materials, rated for the environment.

(2) Where required, raceway fittings shall be provided in explosion-proof configurations rated for the atmosphere. Place conduit seal off fittings at each device in accord with applicable codes. Seal off fittings shall be packed with wadding, and poured with an approved non-shrink sealing compound.

(3) Where conduit transitions in a run from a cold to a warm environment, (such as at a freezer, refrigerator or exterior wall) sealoff fittings shall be placed on the warm side immediately at the boundary to prevent migration of condensation within raceway systems.

(4) Expansion fittings shall be provided at all locations where conduits or other raceways cross over expansion joints. Provide copper ground bonding jumpers across expansion fittings.

(5) Conduit bodies, junction boxes and fittings shall be dust tight and threaded for dusty areas, weatherproof for exterior locations and vapor tight for damp areas. Conduit fittings shall be as manufactured by Crouse Hinds, Appleton, Killark or approved equivalent. All surface mounted conduit fittings as with "FS", "FD", "GUB" Types etc., shall be provided with mounting hubs.

(6) Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint and No. 14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs weight. Fixtures shall be installed plumb and level.

(7) Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.

(8) Fittings for E.M.T. conduit shall be of the compression type. Conduit stops shall be formed in center of couplings. All EMT connectors and couplings shall be of formed steel construction.

(9) Indentation or die-cast fittings shall <u>not</u> be permitted in any raceway system.

(10) All conduit fittings shall be securely tightened. All threaded fittings shall be engaged seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.

J. SUPPORTS AND HANGERS

(1) Supports and hangers shall be installed in accord with all applicable codes and standards. They shall be corrosion - resistant, galvanized or furnished with an equivalent protective coating. All electrical raceways shall be hung independently from the building structure with U.L. listed and approved materials. Hangers and supports depending on the support systems of other trades' work shall not be permitted, except with specific approval in writing from the Engineer. The use of tie wire for support or fastening of any raceway system is prohibited. Perforated metal tape shall not be used for raceway support.

(2) No raceway shall be installed on acoustic tile ceiling tees, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.

(3) Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are <u>not</u> permitted for supports.

(4) The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.

(5) Individual conduits run on building walls or equipment shall be secured by one hole galvanized malleable iron or stamped steel pipe strap or "minerallac" 2-piece straps. The

straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.

(6) Individual conduits run on building steel shall be secured by means of clamp supports similar and equal to those manufactured by the C.C. Korn Company, Elcen Co., B-Line or approved equivalent. Provide korn clamps, bulb tee clamps, flange clamps, beam clamps, "minerallacs", etc.

(7) Where feasible, vertical and/or horizontal runs of conduit shall be grouped in common hangers on "trapezes" of channel stock as manufactured by "Unistrut" or equivalent, 1-5/8" minimum depth, 12 gauge. Utilize conduit clamps appropriate to the channel.

(8) Channel strut systems for supporting electrical equipment or raceways in outdoor wet or corrosive locations shall be constructed of 12 gauge minimum hot dip galvanized steel with 9/16" diameter holes on 8" centers, with finish coat of paint as manufactured by Unistrut, B-Line, Kindorf, or approved equivalent. In indoor dry locations, factory finish paint will be acceptable.

(9) The minimum diameter of round all-thread steel rods used for hangers and supports shall be 1/4", 20 threads per inch. All-thread rod shall be furnished with a corrosion-resistant finish.

(10) Welding directly on conduit or fittings is not permitted.

(11) Provide riser support clamps for vertical conduit runs. Riser support clamps shall be of heavy gauge steel construction. Install riser support clamps at each floor level penetration, or as otherwise required.

(12) Provide conduit cable support clamps for vertical conductor runs as required or indicated on plans. Clamps to be insulating wedging plug, with malleable iron support ring. Install within properly sized and anchored junction box.

(13) Spring steel clips and fittings such as those manufactured by HITT-Thomas, Caddy-Erico, or approved equivalent, with black oxide finish are permitted in any indoor dry location for concealed work, where acceptable to the local authority having jurisdiction.

(14) Provide supports/hangers from each corner of 2x4/2x2/1x4 recesses lay-in style fixtures and connect to structure.

3. INSTALLATION

A. This Contractor shall lay out and install all conduit systems so as to avoid any other service or systems, the proximity of which may prove injurious to the conduit, or conductors which it confines. All conduit systems, except those otherwise specifically shown to the contrary, shall be concealed in the building construction or run above ceilings. Size of all conduit shall as a minimum conform to the National Electrical Code, unless larger size is indicated on the Contract Drawings.

B. No conduit larger shall be installed in poured concrete slabs except with permission of the structural engineer. All other shall be held below slab. Conduit shall be held at least 6" from flues or hot water pipes.

C. All exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart.

D. Conduit shall be installed in such a manner so as to insure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90º bends.

E. Junction boxes shall be installed so that conduit runs will not exceed 85', as shown on the Contract Drawings.

F. Underground electric, cable TV, telephone service or other rigid steel conduit and underfloor rigid steel conduit below the concrete floor slab shall be painted with two coats of bitumastic paint, such as "Asphaltum".

G. All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.

H. At least two 1 inch and four 3/4 inch conduits shall be stubbed from flush-mounted panelboards into the nearest accessible area for future use. Provide suitable closures for these stubs. Identify each stub with a suitable hang tag.

I. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the N.E.C., and NECA "Standard of Installation", complying with recognized industry practices.

J. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.

K. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure or route through joists webbing wherever possible, to maximize available space and not restrict other trades.

L. Complete installation of electrical raceways before starting installation of cables or wires within raceways.

M. All underground conduits shall be buried to minimum depth of 24" from the top of the concrete encasement or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply. Conduits

containing primary power conductors, (higher than 600 volts to ground) shall be 42" to top below finished grade, unless otherwise noted on plans.

N. All raceways shall be installed to maintain a minimum of 4" clearance below roof decking.

4. SPECIALTIES

A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the N.E.C. and other applicable codes.

C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.

D. All pulling lines left in open conduit systems shall be non-metallic, left securely tied off at each end.

E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

END OF SECTION

SECTION 26 05 44 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

   A. Each Contractor's attention is directed to Section 26 05 01, General Provisions, Electrical and all other contract documents as they may apply to his work.

   B. Each Contractor shall include all excavating, filling, grading and related items required to complete his work as shown on the drawings and specified herein.

   C. Electrical distribution lines and underground telephone or TV cables shall, in no case, be placed in the same trench with sanitary, storm, domestic or fire protection water lines. Phone cable may, at the Contractor's option, and if acceptable to both utility companies, be placed in a common trench with power lines as long as 8" of earth separation is maintained. T.V. cable shall, in all cases, be placed in a separate trench with two feet separation from electrical power lines.

   D. Depths of bury shall be as indicated on the drawings.

2. SUBSURFACE DATA

   A. Subsurface investigations have been made and the results shown on the drawings. The information was obtained primarily for use in preparing foundation design. Each Contractor may draw his own conclusions therefrom. No responsibility is assumed by the Owner for subsoil quality or conditions other than at the locations and at the time investigations were made. No claim for extra compensation, or for extension of time, will be allowed on account of subsurface conditions inconsistent with the data shown.

   B. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavation to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating.

3. BENCH MARKS AND MONUMENTS

   A. Maintain carefully all bench marks, monuments and other referenced points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

   A. Each Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation for his work.

   B. Excavate trenches to sufficient width and depth for proper installation of the work and where required, smooth the bottom on the trench with hand tools.

C. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Architect. Any damage to existing structures, exterior services or rock intended for bearing, shall be corrected at the responsible Contractor's expense.

D. Keep trenches free from water while construction therein is in progress. Under no circumstances lay conduit or cable in water. Pumping or bailing water from this Contractor's trenches, which is required during construction shall be accomplished at his expense.

E. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, etc. Each Contractor shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage, or any other damage incurred in the course of excavation, shall be borne by the responsible Contractor.

5. BACKFILL

A. Backfill shall be accomplished with clean debris free earth and the new earth tamped at 12" intervals so as to avoid earth sinks along the trench. The responsible Contractor will be required to return to the project and fill any sunken areas along the route of his work.

B. Backfill trenches only after conduit and cable have been inspected, tested, and locations of pipe lines have been recorded on "as-built" drawings.

C. The backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.

D. The backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATIONS

1. GENERAL

A. Equipment, disconnect switches, motor starters, pushbutton stations, special device plates, and similar materials shall be clearly marked as to their function and use. Markings shall be applied neatly and conspicuously to the front of each item of equipment with 1/2" white lamacoid plate (or equivalent) with black letters 1/4" high.

B. The Contractor shall provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc., controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic card holders in each panel. The Contractor shall be required to demonstrate the accuracy of the panel directory for a random sampling of circuits in each panelboard as directed in the field by the Engineer with corrections made immediately so it is imperative that care be taken during installation to insure 100% accurate directories.

C. All circuit breakers and disconnects serving fire alarm equipment shall be painted red and clearly labeled as Fire Alarm Circuits.

D. Branch circuit panelboards and switch gear shall be provided with a white lamacoid plastic plate with 1/2" black letters for panel designation and 1/4" black letters showing voltage and feeder information. Branch circuit switches shall be designated as to function. Panelboard and switchgear labels shall indicate the source they are fed from, and the circuit number at that source. Panelboards shall also indicate color coding of the branch circuit phase conductors supplied. Clearly indicate the exact label legend to be furnished with each panelboard and switchgear on the shop drawings for each item of equipment prior to submission of shop drawings.

EXAMPLE:

PANEL “XYZ” FED FROM “MDP – 2” 120/ 208/ 3PH/ 4W – 225A BLACK-RED-BLUE CONDUCTORS

E. Where branch circuit panelboards and switchgear are connected to an emergency source, the lamacoid plate shall be red, and the word "emergency" shall be incorporated into the legend. In healthcare applications, the NEC – designated branch (life safety, critical or equipment branch) shall also be incorporated into the legend, all in ¼” letters. Also provide similar plates and legends for automatic transfer switches, and equipment disconnects 100 amps and larger.

F. Lamacoid plates shall be located at center of top of trim for branch circuit panels, switch gear, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method.

G. The building service disconnect(s) shall be marked with the maximum available fault current available at that location in accordance with NEC Article 110. If a fault current study is not required by this contract, the Contractor shall obtain fault current availability data from the utility company. This requirement applies to both new and existing services if any distribution equipment is changed.

END OF SECTION

SECTION 26 05 73 - ELECTRICAL STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All services, materials and installation shall comply with the owners' construction standards. Special attention shall be given to Divisions 02, 16 and 17. In the event of a conflict between these standards and the Contract Documents the most stringent requirement shall be met.

C. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.

D. Each Electrical Contractor's attention is directed to Section 26 05 01 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

1.2 SUMMARY

A. This Section includes computer-based, fault-current, arc flash and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

B. Electrical Studies shall be performed by the Low-Voltage Switchboard manufacturer. All Electrical Studies required by this specification shall be completed within five (5) weeks from award of project. The Electrical Contractor shall provide all required data to Low-Voltage Switchboard manufacturer within one (1) week and the manufacturer will have four (4) weeks to complete the studies.

C. A licensed professional engineer employee of the Low-Voltage Switchboard manufacturer shall provide electrical power system studies for the project using the latest version of one of the approved software packages. The software model files shall be submitted with the report. The analysis shall follow the latest IEEE 1584 guidelines. An example report will be provided by the university upon request.

D. Studies specified herein must be submitted and approved prior to release of any affected equipment. Revisions to equipment or devices necessary to meet study recommendations shall be at the Manufacturer's expense.

E. All adjustments and settings recommended by these studies shall be made prior to any testing.

F. The analysis shall be submitted to the engineer of record prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

E. Owners Record Copy: The as-built software model and all electronic files are to be provided to the owner at project closeout. Electronic files are to be compatible with the latest version of SKM software. The owner shall receive rights to use and/or modify the electronic files and data for operations planning, maintenance and modification of their electrical system.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

1.5 Commissioning

A. This section specifies a system or a component of a system being commissioned as defined in Section 019113 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 019113 Commissioning for detailed commissioning requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Software utilized shall be capable of converting all data to SKM formatting. Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings

and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated, including arc-reduction features where applicable.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Data shall be obtained for the power sources (utility system and generators), impedance components (transformers, cables and busway), overcurrent protective devices (fuses, circuit breakers and relays) and other relevant equipment such as automatic transfer switches. Cable data (length, quantity per phase, size and type) shall be provided by the electrical contractor. Assumptions should only be used when the actual data is not available and the assumptions should be clearly listed in the report. Assumptions shall be kept to a minimum.

C. A one-line diagram shall be provided as part of the analysis and shall clearly identify individual equipment buses, bus numbers used in the analysis, cable information (length, quantity per phase, size and type), overcurrent device information (manufacturer, type and size), transformers, motors, transfer switches, generators, etc.

D. The one line and analysis shall use a numbering scheme where each bus begins with a three digit number followed by a description (e.g., 102 MDPA or 103 ELEV DISC) and each connected circuit breaker or fuse shall have a corresponding designation (e.g., 102-1 MAIN CB, 102-2 ELEVATOR FDR or 103-1 ELEV DISC CB).

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus
2. Utility transformer
3. Distribution panelboards
4. Branch circuit panelboards
5. Variable Frequency Drives
6. Motor Control Centers
7. Company switches
8. Fused and non-fused disconnects
9. Low-voltage transformers
10. Individual circuit breakers
11. Automatic transfer switches
12. Generator
13. Combination starter/disconnects

B. Study electrical distribution system from normal and alternate emergency power sources throughout electrical distribution system for Project, using approved computer software program. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10
b. ANSI C57.12.22
c. ANSI C57.12.40
d. IEEE C57.12.00
e. IEEE C57.96

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.
4. Circuit Breakers: IEEE c37.13.

E. Study Report: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. A table shall be included which lists the calculated short-circuit currents (rms symmetrical three phase), equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment at each bus.

H. Any inadequacies shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
    a. Inrush current when first energized.
    b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage

insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

H. A table shall be included which lists the recommended settings of each circuit breaker and relay.

I. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

J. Deficiencies in protection and/or coordination shall be called to the attention of the engineer of record and recommendations made for improvements as soon as they are identified.

K. The electrical engineer that performed the study shall be responsible to set the circuit breakers according to the analysis once the report has been approved by the engineer of record.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The analysis shall consider multiple possible utility scenarios as well as multiple system configurations where appropriate such as normal and emergency transfer switch positions and different main-tie-main configurations. Where manually activated arc energy reduction means are utilized, the analysis shall calculate energy available downstream for normal operation and for maintenance mode operation.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system. This includes all switchboards, switchgear, motor-control centers, panelboards, busway and splitters.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment locations. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendation for arc flash energy reduction

M. The Arc Flash Hazard Analysis shall include recommendations for reducing Arc Flash Incident Energy (AFIE) levels and enhancing worker safety.

N. Results of the Arc Flash Hazard Analysis shall be submitted in tabular form and shall include the following information for each bus location: bus name, protective device name, bus voltage, bolted fault, arcing fault, trip/delay time, equipment type, working distance, arc flash boundary, incident energy and protective clothing category.

3.6 ARC FLASH WARNING LABELS

A. Arc flash labels shall be furnished and installed by the contractor of the Arc Flash Hazard Analysis.

B. The labels shall be 4 inches high by 6 inches wide and printed on a Brady THTEL-25-483-1-WA label type or similar. The arc flash label shall be as required by NFPA 70E or as required by the owner's standards.

C. After labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

3.7 Labels shall be machine printed, with no field markings.

3.8 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. Provide one arc flash label for all electrical equipment including:

A. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.

B. For each 480 and applicable 208 volt distribution panelboard, one arc flash label shall be provided.

C. For each motor control center, one arc flash label shall be provided.

D. For each low-voltage switchboard, one arc flash label shall be provided.

E. For each switchgear, one flash label shall be provided.

F. For medium voltage switches and transformers, one arc flash label shall be provided.

G. For each fused or non-fused disconnect switch, one arc flash label shall be provided.

H. For each generator and automatic transfer switches, one arc flash label shall be provided.

I. For each variable frequency drives, one arc flash label shall be provided.

J. For each combination starter/disconnects, one arc flash label shall be provided.

K. For each fused or non-fused disconnect switch and individual circuit breakers, one arc flash label shall be provided.

L. For each low-voltage transformer, one arc flash label shall be provided.

M. For each company switch, one arc flash label shall be provided.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes requirements for commissioning lighting systems, assemblies, and equipment.

1. Commissioning is a third-party quality assurance process. It does not take the place of or duplicate the Contractor's quality control services required per Division 01 Section "Quality Requirements" or testing, adjusting, and balancing and other quality control testing or inspections required in individual Sections and normally the responsibility of the Contractor.

B. The following lighting systems, equipment and components are to be commissioned on this project:

Electrical	CxP Submittal Review	Construction Checklist	Functional Test Sampling
26 51 16 Network Lighting Systems	Yes	Yes	10%
26 27 26 Wiring Devices	Yes		10%
Electrical Service and Distribution	Yes		Witness Tests & Inspections

C. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for definitions of terms used in this Section, and for commissioning requirements applicable to all systems, including lighting.

1.2 INFORMATIONAL SUBMITTALS

A. Contractor Submittals and Shop Drawings: Concurrent with AE review, the Contractor will send submittals relating to systems to be commissioned to the CxP for review of compliance with the Contract Documents. Comments will be returned directly to the AE with a copy to the Owner for coordination of a final submittal review response from the AE to the Contractor. This includes all Division 26 submittals for systems referenced in 1.1 above.

B. Commissioning Documentation: Submit the following information to the CxP:

1. Schedule: Schedule for completing construction checklists, pre-functional and start-up for lighting systems, assemblies, equipment and components to be commissioned.
2. Test Equipment, Instrumentation, and Tools: Submit list of test equipment, instrumentation, and tools required to perform functional performance testing. Identify

proprietary test equipment, instrumentation, and tools. Include calibration certificates for test equipment and instrumentation.

3. Checklists: Completed construction checklists, pre-functional checklists and start-up forms for each piece of equipment or component.
4. Certificate of Readiness: Using FPT Certificate of Readiness form provided in Division 01 "General Commissioning Requirements," certify that lighting systems, subsystems, equipment, components, and associated controls are ready for testing.
5. Documentation of corrective actions for logged deficiencies.

1.3 CLOSEOUT SUBMITTALS

A. Commissioning issues reports showing resolution of issues.

1. Include correspondence or other documents related to resolution of issues.
2. List unresolved issues. Provide written explanation for why each item on the list remains unresolved. Indicate reason, if any, are exempt from the requirements for Construction Phase Commissioning Completion.

B. Training verification forms.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. General: Provide test equipment, instrumentation, and tools necessary to perform function performance testing. Use test equipment and instrumentation that has been calibrated, certified, and properly maintained.

1. Test equipment and instrumentation required to perform the commissioning shall remain the property of Contractor unless otherwise indicated.
2. Proprietary test equipment, instrumentation, and tools shall become the property of Architect at Substantial Completion.

a. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate or perform work on its equipment.

PART 3 - EXECUTION

3.1 COMMISSIONING PROVIDER (CxP) RESPONSIBILITIES

A. Meetings: Attend and lead commissioning team meetings.

B. Checklists: The CxP shall develop and provide Project-specific construction checklists.

C. FPT Procedures: The CxP shall develop and provide functional performance test procedures for lighting systems, assemblies, equipment and components, including to verify operation and integration of new components in existing systems.

D. FPT Testing: The CxP shall witness functional performance testing, and record test results.

E. Commissioning Record: The CxP shall author a commissioning summary report and verify functional performance test data and certificates are included in the commissioning record.

3.2 CONTRACTOR RESPONSIBILITIES

A. Meetings: Attend and participate in commissioning team meetings.

B. FPT Testing: Perform functional performance testing for systems, assemblies, equipment, and components indicated to be commissioned.

C. Documentation: Provide information requested by the CxP.

D. Training: Participate in training for lighting systems, assemblies, equipment and components.

E. Near-End-of-Warranty Walkthrough: Participate in the Near End-of-Warranty review meeting and walkthrough.

3.3 ELECTRICAL DISTRIBUTION

A. 3rd Party testing and inspection performed on the following shall be sample witnessed by the CxP and all testing & inspection documentation is to be forwarded to the CxP for review and inclusion in the final commissioning record:
1. Grounding
2. Transformers
3. Surge Suppression Systems

1.2 FUNCTIONAL PERFORMANCE TESTING (FPT) PREPARATION – EMERGECNY POWER

A. The CxP shall witness the generator and ATS start-up, and load-bank test.

3.4 FUNCTIONAL PERFORMANCE TESTING (FPT) PREPARATION - LIGHTING

A. Start-up: Certify that lighting systems, subsystems and equipment have been installed, calibrated and started and are operating according to the Contract Documents.

B. Participation: Coordinate schedule to ensure that all required members of the commissioning team as indicated in functional performance testing (FPT) procedures are available to participate in FPT.

3.5 GENERAL FPT REQUIREMENTS

A. General: Test all normal and emergency modes of operations including alarms.

1. To greatest extent possible, use design conditions for test parameters, unless otherwise directed by Architect and CxP.
2. Simulated conditions may be imposed to initially test systems; however, this does not relieve the Contractor of his duty to perform deferred testing. Alter set points and sensor values when simulating conditions is not practical.

B. Re-Testing:

1. If tests indicate that system, assembly, equipment, or component does not meet acceptance criteria indicated, document the deficiency and report it to the Architect. Upon resolution of deficiencies, re-test using same original parameters unless otherwise directed by Architect and CxP. Notify Architect and CxP a minimum of three days before re-test date of rescheduled tests.
2. Deficiencies which prevent the verification of system performance may be uncovered during tests. In cases where the issue cannot be resolved within a reasonable amount of time, document the deficiency and report it to the Architect. Upon resolution of deficiencies, re-test using same original parameters unless otherwise directed by Architect and CxP. Notify Architect and CxP a minimum of three days before re-test date of rescheduled tests.

3.6 EMERGENCY POWER FPT PROCEDURES

A. A 'pull the plug' test shall be performed. The contractor shall perform the test for the CxP to witness. A run time up to 2 hours on the generator is expected as the CxP walks the building to verify all lighting and equipment on emergency power is energized.

3.7 LIGHTING FPT PROCEDURES

A. Typical Lighting Controls:

1. Procedures:

a. Test 4 zones or 10 percent of the zones, whichever is greater. If any zone fails to meet the acceptance criteria, then test another 2 zones or 10 percent of the zones, whichever is greater. If any zone fails to meet the acceptance criteria in the second sampling, then test the remaining zones and document the test results using a format acceptable to the Architect and CxP. Retest any zone that fails to meet the acceptance criteria.
b. Verify time of day schedules and setpoints.
c. Utilize active testing, and trending when available. If able to trend, trend all zones over a week period.

B. Occupancy Sensor Lighting Controls:

1. Procedures:

a. Test 6 sensors or 10 percent of the sensors, whichever is greater. If any sensor fails to meet the acceptance criteria, test another 6 sensors or 10 percent of the sensors, whichever is greater. If any sensor fails in the second sampling, test the remaining sensors and document the test results using a format acceptable to the Architect and CxP. Retest any sensor that fails to meet the acceptance criteria.
b. Test all units' functions, including sensor sensitivity and time-to-OFF functions and ensure that sensor location is proper and won't be tripped inadvertently by other occupants and movements outdoors, etc.
c. Utilize active test methods.

2. Acceptance Criteria: Reasonable sensitivity, no inadvertent trips, lights go off within 15 seconds of design.

C. Daylighting Controls:

1. Procedures:

a. Test 4 sensors or 10 percent of the sensors, whichever is greater. If any sensor fails to meet the acceptance criteria, test another 4 sensors or 10 percent of the sensors, whichever is greater. If any sensor fails in the second sampling, test the remaining sensors and document the test results using a format acceptable to the Architect and CxP. Retest any sensor that fails to meet the acceptance criteria.
b. Photo sensors at connected luminaires shall respond to varying ambient light levels appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance

3.8 NEAR END-OF-WARRANTY REVIEW

A. General: Participate in the Near End-of-Warranty review and walkthrough conducted by the CxP.

1. The review will cover current building operation with input from the operation and facility staff. Outstanding issues related to the construction, particularly those related to Owner's Project Requirements (OPR), and warranty related deficiencies will be addressed. Operational problems and concerns from the facility staff and occupants will be reviewed for compliance with design intent.
2. The CxP will provide a plan for corrective measures to the Architect and the Contractor for action.
   a. Corrective Action: Where deficiencies and problems result from work not in compliance with the Contract Documents or are covered under warranty, provide the corrective actions indicated at no additional cost to Architect.

END OF SECTION 26 08 00

SECTION 26 24 00 - ELECTRICAL DISTRIBUTION EQUIPMENT

1. GENERAL

   A. All electrical distribution equipment shall be dead front UL listed for the purpose and application. All equipment shall meet or exceed all applicable requirements of the National Electrical Code (N.E.C.). Any device or component, i.e., switchboard, panel, breaker, switch, etc., used as service entrance equipment, shall be listed for use at 100% of the rated capacity.

   B. Provide building with submetering system. Provide E-GAUGE or similar for each panel / distribution board in the building. Provide complete with CTs and network connection.

2. MAIN SWITCHBOARD - CIRCUIT BREAKER STYLE

   A. Switchboard shall be dead front, totally enclosed, free standing or wall mounted, as required or herein specified, housing the equipment as indicated. The switchboard shall meet Underwriters' Laboratories enclosure requirements, and be furnished with an Underwriters' Laboratories label. The entire switchboard is to be Square D I-Line or equivalent construction, G.E., Siemens, Eaton / Cutler - Hammer or approved equivalent. Where switchboards are floor-mounted, provide concrete housekeeping pad, 3" high, with #4 rebar on 6" X 6" centers, per A.C.I. standards. Chamfer edges of pad 1/2".

   B. Provide PEPCO approved pull section at entry of switchboard.

   C. The switchboard shall be dead-front with front accessibility. The switchboard framework shall consist of steel channels bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed of code gauge steel, rigidly welded together to support all cover plate, bussing and component devices. All unused positions shall have closures.

   D. Each switchboard section shall have an open bottom (closed for wall-mounted style) and a top plate for installation and termination of conduit. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings. The wireway front covers shall be secured by screws and hinged, to permit access to the branch circuit breaker load side terminals. The paint finish shall be medium light gray, per ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment. Enclosure shall be NEMA 1, with drip shield on top. Provide top covers without knockouts. All conduit entries to be field cut. At top conduit entries, provide weatherproof sealing lock nuts on terminator.

   E. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise. Main and/or through busses shall be 100% annealed copper. The through bus shall have an ampacity in amperes as indicated on the drawings and shall be braced to have a short circuit current rating of 100,000 RMS symmetrical amperes unless otherwise indicated. (Where through bus is provided, it shall have provisions for the addition of future sections on the branch or distribution side.) The through bus supports, connections and joints are to be bolted with hex head bolts and belleville washers to minimize maintenance requirements.

F. Neutral bussing shall be of the same ampacity bussing and insulated from the enclosure. Ground bussing shall be sized and shall be bonded to the enclosure per N.E.C., current edition. Service grounding electrode connection shall be made between ground and neutral busses. Provide ground bushings and equipment ground conductor connection on each feeder conduit leaving switchboard and at the terminal end for each continuous metallic feeder conduit.

G. Each switchboard, as a complete unit, shall be given a single short circuit current rating by the manufacturer. Such a rating shall be established by actual tests by the manufacturer, in accordance with UL specifications, on equipment constructed similarly to the subject switchboard.

H. The service disconnect device(s) shall be thermal-magnetic molded case circuit breaker(s) installed totally front accessible and front connectable. Line side of branch circuit breaker connections are to be jaw type plug-on. Ground fault protection shall be provided as required by N.E.C. Article 230-95, where switchboard is rated for 277/480 volts and circuit breaker frame sizes are 1000 amperes or greater, regardless of trip setting.

I. Group mounted molded case circuit breakers for branch distribution are to be totally front accessible. These circuit breakers are to be mounted in the switchboard to permit installation, maintenance and testing without reaching over any line side bussing. All line and load side connections are to be individual to each circuit breaker. Common mounting brackets or electrical bus connectors will not be acceptable. Line side circuit breaker connections are to be jaw type plug-on, arranged to withstand the anticipated fault currents.

J. Each circuit breaker is to be furnished with an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate as well as exercise the circuit breaker operating mechanisms.

K. Include kw, kwh, voltage, amperage metering per phase along with appropriate digital output to interface with campus DDC control system for remote monitoring of power system. Coordinate with controls supplier for a 100% complete installation.

L. Provide an arc energy reducing maintenance switch with local status indicator for all breakers or equipment rated or adjustable to 1,200 Amps or greater. Provide a local status indicator light for all breakers equipped with maintenance switches. Maintenance switch and indicator shall be mounted to the breaker face or immediately adjacent to the breaker in the switchboard enclosure. Maintenance switch shall have permanently mounted lockout/tagout provisions. Provide labelling to indicate operation instructions for maintenance switch at each switch.

M. All circuit breakers shall have a minimum ISCA rating of 65,000 amps, A.I.C., unless otherwise noted on the One-Line Diagram.

N. Arc Flash Hazard warning labels shall be affixed to all switchboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.

O. Switchboard shall be Square "D", G.E., Siemens, Eaton/Cutler–Hammer or approved equivalent.

P. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

3. DISTRIBUTION PANELBOARDS (600 AMPERE OR GREATER)

A. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge steel, with gray baked enamel finish electrodeposited over cleaned, phosphatized steel.

B. The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Bus structure shall be full height of panel.

C. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50ºC. rise above ambient. Heat rise tests shall be conducted in accordance with Underwriters Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All panelboards unless otherwise noted shall have space to accept forty-two 20 amp one pole circuit breakers.

D. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF." Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. All panelboards shall be capable of accepting 225 amp 3 pole branch breakers as a minimum unless otherwise noted.

E. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on schedules on the plans or as determined by verification with local utility company. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

F. Arc Flash Hazard warning labels shall be affixed to all panelboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.

G. Provide energy reducing maintenance switch with local status indicator for any breaker or equipment rated or adjustable to 1,200 Amps or greater.

H. Distribution panelboards shall be Square "D", G.E., Siemens, Eaton/Cutler–Hammer or approved equivalent.

I. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

4. BRANCH PANELBOARDS

A. This section covers lighting and power panelboards (refer to schedules, notes on Drawings and the Electrical One-Line Diagram, of the Contract Drawings).

B. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.

C. Branch panelboards shall be as indicated on the drawings and as specified herein. The lighting panelboards shall be of the dead-front, quick-make, quick-break, plug-in circuit breaker type, with trip indicating and trip free handles. All circuits shall be clearly and properly numbered and shall be provided with thermal magnetic protection. The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished hinged doors without visible external fasteners and heavy chrome locks. Locks shall all be keyed alike. Each door shall have a directory card inside, covered with a plastic shield, filled in with black india ink or typewritten with circuit numbers and description indicated. Room numbers shall be coordinated with final room numbers as selected by Owner -- not numbers on Contract Documents.

Special Note: The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall not be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Architect or Engineer.

D. Branch panelboards shall be surface or flush mounted as indicated on the Contract Drawings.

E. Circuit breakers for 120/208 volt systems shall be of 10,000 A.I.C. RMS symmetrical rating unless otherwise indicated on the Contract Drawings or Fault Current Study. For 277/480 volt systems, provide circuit breakers with 14,000 A.I.C. ratings unless otherwise indicated or Fault Current Study.

F. All main bus and connections thereto in branch panelboards shall be copper. All bus bars shall extend full length of panelboards.

G. All circuit breakers used to switch lights shall be SWD (switching duty) rated and U.L. listed for the purpose.

H. Where branch circuit breakers feed hermetically, sealed compressor for cooling or refrigeration equipment, provide U.L. listed H.A.C.R.-style circuit breakers.

I. Where branch circuit breakers are indicated or required to be ground-fault circuit-interrupting type (G.F.C.I.), they shall have test and reset buttons and be U.L. listed, latest edition. Do not share neutrals with other circuits.

J. Where branch circuit breakers are feeding H.I.D. (high-intensity-discharge) loads, they shall be rated and listed for such loads. Provide proper circuit breaker whether indicated on panel schedules or not.

K. Arc Flash Hazard warning labels shall be affixed to all panelboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.

L. Panels shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.

M. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

5. INSTALLATION INSTRUCTIONS

A. Panelboards with circuit breakers installed before the building has been finished and cleaned shall be masked.

B. All dust and debris shall be removed from the panels before they are energized and placed in service.

C. All panelboard fronts shall be omitted until final punch list inspection is made. Directories for each panelboard shall be completed and available for review by the Engineer at that time.

D. All service equipment shall be marked with the maximum available fault current and the date of the calculation. This information shall be obtained in writing from the serving utility. Provide label adjacent to the service disconnecting means. Document action of the fault current shall be included in the operation and maintenance manual. This labeling shall be provided for all new service installations, service upgrades, and any project that adds or replaces distribution panels or branch panel boards.

E. Where applicable - Provide a warning sign on the service entrance equipment indicating type and location of all on-site emergency power sources in accordance with the NEC.

F. Where applicable – Provide warning sign(s) for alternative power devices (photovoltaic, wind, fuel cell, etc.) on all equipment in accordance with the NEC.

G. All emergency system switchgear, distribution panels and branch panelboards shall be provided with surge protection devices in accordance with the NEC. Refer to Section 264313 Surge Suppression Systems.

6. SAFETY SWITCHES

A. Provide heavy duty safety switches as a final disconnecting means as required by NEC and/or as indicated on the Contract Drawings.

B. All safety switches shall be NEMA Type 1, NEMA 3R, NEMA 4 stainless steel, NEMA 12, or as required by the operating environment, Heavy Duty Type HD, UL listed.

C. All safety switches shall have switch blades that are fully visible in the "OFF" (open) position with the door open.

D. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.

E. Switch mechanism shall be quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.

F. Arc Flash Hazard warning labels shall be affixed to all switches in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.

G. Switches shall be as manufactured by Square D., G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.

7. FUSES

A. Upon completion of the building, the Contractor shall provide the owner with spare fuses as shown below. All fuses shall be Bussmann, Shawmut, Gould or Reliance.

(1) 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares:

(2) Bussmann spare fuse cabinets - Catalog No. SFC - shall be provided to store the above spares.

B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to insure retention of selective coordination, as designed.

C. Circuits 601 to 6000 amperes shall be protected by current limiting BUSSMANN HI-CAP TIME DELAY FUSES KRP-C. Fuses shall employ "O" rings as positive seals between the end bells and the fuse barrel. Fuses shall be a time-delay type and must hold 500% of rated current for a minimum of 5 seconds, clear 20 times rated current in .01 seconds or less and be listed by Underwriter's Laboratories, Inc., with an interrupting rating of 200,000 amperes R.M.S. symmetrical. The fuses shall be UL Class L.

D. Circuits 0 to 600 amperes shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts). All dual element fuses shall have separate overload and short circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284°F melting point alloy and shall be independent of the short-circuit clearing chamber. The fuse shall hold 500% of rated current for a minimum of l0 seconds and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. The fuses shall be UL Class RK1.

E. Motor Circuits - All individual motor circuits rated 480 amperes or less shall be protected by BUSSMANN LOW PEAK DUAL-ELEMENT FUSES LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in rating approximately l25% of motor full load current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the Type KRP-C HI-CAP Time Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPN-RK (250 volts) or LPS-RK (600 volts) installed in rating approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

F. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual Element fuses LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

END OF SECTION

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SECTION 26 24 50 - ELECTRICAL DISTRIBUTION TRANSFORMERS

1. GENERAL

   A. All electrical distribution transformers shall be dead front UL listed for the purpose and application. All equipment shall meet or exceed all applicable requirements of the National Electrical Code (N.E.C.).

2. QUALITY ASSURANCE

   A. Manufacturer shall be ISO 9001 certified.
   B. Transformers shall be CSA certified and UL listed [CE certified outside North America],
   C. Transformers shall be factory tested to CSA C9,
   D. Transformers shall meet all relevant CSA, EPA, IEEE, NEMA, NFPA, and UL standards.

3. SHOP DRAWING SUBMITTALS

   A. Submit shop drawings, in accordance with Section 26 05 03 – Submittals, that includes:

      (1) Enclosure dimensions,
      (2) Mounting devices,
      (3) Terminals,
      (4) Taps,
      (5) Internal and external component layout,
      (6) Amperage (neutral),
      (7) kVA rating,
      (8) Voltage,
      (9) Frequency,
      (10) BIL,
      (11) Insulation class.

4. INSTALLATION INSTRUCTIONS

   A. All Transformers shall be installed within 10 linear wire feet of the secondary means of disconnect, or a N.E.C. compliant means of disconnect shall be provided.
   B. A minimum of six (6”) inch air gap shall be provided between transformer and wall if located adjacent to wall.
   C. Provide a 4” concrete house keeping pad for all floor mounted transformers in accordance with A.C.I. standards.
   D. Provide 4” x 4” x ¾” nominal thick vibration isolation pads, four per transformer. Pads shall be Korfund Co. or equal. Transformer is to be anchored in a manner that minimizes transmission of vibration.

5. TYPE “D” DISTRIBUTION TRANSFORMERS

A. The Contractor shall provide dry-type transformers as manufactured by Power Smith, Power Quality International, Square "D" or equivalent. KVA ratings shall be as indicated on the electrical plans, transformers shall have copper windings.

B. Three phase transformers are to have 480 volt Delta primary and 120/208V/3 /4W secondary. 30 KVA transformers and larger are to be supplied with 2-1/% full capacity taps above and (4) 2-1/2% full capacity taps below primary voltage. Exceptions to the above will be shown on the electrical plans.

C. Transformer coils shall be vacuum impregnated with non-hygroscopic, thermosetting varnish. Each layer shall have end fillers or tie downs to provide maximum mechanical strength. Insulation systems and their construction techniques shall be listed by Underwriters Laboratories.

D. Transformer coils shall have a final wrap of electrical insulating material designed to prevent injury to the coil wire. Transformers having coils with magnet wire visible will not be acceptable.

E. All cores to be manufactured from high grade, non-aging, silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses. Magnetic flux densities are to be designed below saturation as required to allow for a minimum of 10% over voltage excitation. The cores shall be clamped with structural angles (formed angles not acceptable) and bolted to the enclosure to prevent damage during shipment or rough handling.

F. The core and coil unit shall be completely isolated from the enclosure by means of a vibration isolating system and shall be so designed as to provide for continual securement of the core and coil unit to the enclosure. Sound isolating systems requiring the removal of all tie down facilities will not be acceptable.

G. Primary winding configuration must be 'Delta'.

H. Secondary winding configuration must provide a zero-sequence reactance of <0.2% at 60Hz at any primary to secondary phase shift.

I. Secondary winding configuration must provide a zero-sequence impedance of<0.9% at 60Hz at any primary to secondary phase shift.

J. Transformers 15 KVA thru 45 KVA shall be provided with interchangeable mounting for floor or wall.

K. The maximum top of case temperature shall not exceed 35°C above ambient.

L. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed and finished with baked enamel.

M. The core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.

N. Sound levels shall be guaranteed by the manufacturer and substantiated by certified tests on each unit furnished. The sound levels are not to exceed the following values: 10 to 45 KVA, 42 D.B. to 150 KVA; 45 D.B., 225 to 300 KVA; 50 D.B. and 500 KVA, 54 D.B.

O. If a particular "K" rating is specified for a dry-type transformer, that rating shall be provided.

P. Insulation Class: R (220°C) and shall have the ability to carry a continuous 15% overload without exceeding a 220°C rise above 40° ambient.

Q. Magnetic field at 1.5 feet: max. 0.1 Gauss

R. Transformer shall provide an ultra-low zero-sequence impedance path in its secondary three-phase, four-wire subsystem for all zero-sequence currents, including 3rd, 9th, 15th, 21st harmonics, ---.

S. Transformer shall provide a primary-secondary phase-shift of 0 degree in order to achieve cancellation of 5th, 7th, 11th, 13th, 17th, 19th, 23rd, 25th, --- positive- and negative-sequence harmonic currents on the units' primary bus, equal to the lesser source of each individual harmonic current through each model, thereby treating all of the foregoing harmonic currents.

T. NEMA TP1 linear-load efficiency at 35% full load must be verified by NEMA TP2 test method. In addition, non-linear efficiency at 35% full load must be verified by Voltage & Current Difference Measurement Method.

U. Anti-vibration pads shall be used between the core and the enclosure.

V. e-Rated® Efficiency: US DOE-CSL3 efficiency requirements.

W. TVSS (parallel) – 160,000 Amps per Phase (L-N, L-L, N-G all at 80,000 Amps each)

X. Linear Load Efficiency: The transformer shall meet the efficiency requirements of NEMA TP1-2002, EPA Energy Star® and CSA C802.2-00, which are linear load efficiency requirements. Proof of compliance Type Tests, for each transformer type and rating, must be based on NEMA TP2-1998 – 'Standard Test Method for Measuring the Energy Consumption of Distribution Transformers'. Type Test are required with each submission

Y. Non-Linear Load Efficiency: The transformer shall meet the efficiency requirements of NEMA TP1-2002 under non-linear loading, which has 100% THDI and a harmonic profile that is based on IEEE Std. 519-1992, Table 4.3 – 'Spectrum of Typical Switch Mode Power Supplies'. Proof of compliance Type Tests, for each transformer type and rating, must be based on the Voltage and Current Difference Measurement Method, with a minimum accuracy of 0.033%. Type Tests are required with each submission. The Power In – Power Out Measurements Method is not acceptable.

Z. Linear and non-linear losses and efficiencies, which are based on the Sections Y and Z, between 25% full load and 100% full load, must be plotted for each type and kVA rating.

6. REQUIREMENTS & CERTIFICATIONS

A. Evidence of significant relevant application experience.

B. Quantitative performance data including before/after effect on voltage distortion at load panels that demonstrates the capability to achieve the harmonic mitigation called for in this specification.

C. Manufacturer shall be ISO 9001 certified.

D. Device shall be UL Listed, CSA certified and CE Listed.

7. WARRANTY

A. Manufacturer shall guarantee that the product will perform as described in Section 2.2 of this specification.

B. Manufacturer shall warrant the product against defective materials and workmanship.

C. Minimum terms and conditions: 10 year pro-rated, with standard limited liability clauses.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES AND PLATES

1. GENERAL

A. This section of the specifications includes wiring devices, cover plates, weatherproof and dust-tight closures, communications devices and floor outlets.

B. Wiring devices are listed by manufacturer and catalog numbers to establish the quality and type required. Equivalent devices of other manufacturers will be acceptable with prior approval of the Engineer. Submit cutsheets and/or samples of each type ten days prior to bid date for review and written approval to bid. Insofar as possible, standard application or special application devices shall be by one manufacturer.

2. MATERIALS

TYPE	**RATING**	**CONFIGURATION**	**COLOR**	**VENDOR - CAT. #**
RECEPTACLE - DUPLEX **COMMERCIAL GRADE**	125V, 20A 125V, 15A	NEMA 5-20R NEMA 5-15R	□ □	HUBBELL CR5362* GE 5362* LEVITON 5362* HUBBELL CR5262** GE 5262** LEVITON 5262**
	* USE WHEN ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHEN ON DEDICATED 15A CKT., OR WHEN MORE THAN ONE RECEPTACLE ON A CIRCUIT			
RECEPTACLE - DUPLEX **PREMIUM GRADE**	125V, 20A 125V, 15A	NEMA 5-20R NEMA 5-15R	□ □	HUBBELL 5352* LEVITON 5362* GE 5362,* HUBBELL 5252** LEVITON 5262** GE 5262**
	* USE WHERE ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHERE ON DEDICATED 15A CKT., OR WHERE MORE THAN ONE RECEPTACLE ON A CIRCUIT			
RECEPTACLE - DUPLEX G.F.I.	125V, 20A	NEMA 5-20R	□	HUBBELL GFR5352A

(SHALL MEET U.L. 943 STANDARD)				
RECEPTACLE - SIMPLEX	125V, 20A	NEMA 5-20R	□	HUBBELL 5361
RECEPTACLE - DUPLEX, SAFETY TYPE (WITH TAMPER-RESISTANT SCREWS)	125V, 20A	NEMA 5-20R	□	HUBBELL HBL-8300-SG
RECEPTACLE - DUPLEX, SAFETY TYPE (WITH TAMPER-RESISTANT SCREWS)	125V, 15A	NEMA 5-15R	□	HUBBELL HBL-8200-SG
RECEPTACLE, SIMPLEX WITH CLOCK HANGER TAB, STAINLESS STEEL PLATE	125V, 15A	NEMA 5-15R	METAL	HUBBELL 5235 LEVITON 658-BR ARROW-HART 5760
RECEPTACLE, DUPLEX RED COLOR NYLON FACE (FOR EMERGENCY POWER OUTLETS)	125V, 20A	NEMA 5-20R	RED	HUBBELL 5352-RDB GE 5362-RDB LEVITON 5362-RDB
RECEPTACLE, DUPLEX ISOLATED GROUND WITH SURGE SUPPRESSION, INCLUDING INDICATOR LIGHT	125V, 15A	NEMA 5-15R	BLUE DEVICE	HUBBELL 5250S LEVITON 5380 ARROW-HART 5362
RECEPTACLE, SINGLE	250V, 20A	NEMA 10-20R	BLACK	HUBBELL 6810 GE 4124 LEVITON 5032
RECEPTACLE, SINGLE	250V, 30A	NEMA 6-30R	BLACK	HUBBELL 9330 GE 4139 LEVITON 5372
RECEPTACLE,	250V, 50A	NEMA 6-50R	BLACK	HUBBELL 9367

SINGLE				GE 4141 LEVITON 5374
SWITCH, SINGLE POLE	120/277V, 20A	SPST	□	HUBBELL HBL-1221 GE 5951 LEVITON 1221
SWITCH, SINGLE POLE - RED TOGGLE (WITH RED COVER PLATE, FOR EMERGENCY LIGHTING CONTROL)	120/277V, 20A	SPST	RED	HUBBELL HBL-1221-RDB GE 5951-RDB LEVITON 1221-RDB
SWITCH, THREE-WAY	120/277V, 20A	3-WAY	□	HUBBELL HBL-1223 GE 5953 LEVITON 5953

NOTE:

SWITCH, KEYED TO EACH BE FURNISHED WITH ONE HUBBELL #1209 KEY. TURN OVER TO OWNER AT CLOSE OF PROJECT AND OBTAIN RECEIPT FOR VERIFICATION THAT KEYS HAVE BEEN DELIVERED.

NOTES:

1. PROVIDE MATCHING CAP (PLUG) FOR ALL RECEPTACLES 30 AMP RATED AND ABOVE AS REQUIRED FOR EQUIPMENT.

2. ALL RECEPTACLES SHALL BE BACK OR SIDE-WIRED, CLAMPING TYPE

3. FOR DRYERS AND RANGES, PROVIDE 3-POLE GROUNDING TYPE AS REQUIRED BY DEVICE. LOCATE DEVICE SO THAT DRYER OR RANGE CAN BE PUSHED TIGHTLY AGAINST WALL.

4. RECEPTACLES SHALL BE TAMPER RESISTANT AND WEATHER RESISTANT AND MARKED ACCORDINGLY AS REQUIRED BY N.E.C.

5. ALL RECEPTACLES INSTALLED IN DAMP OR WET LOCATIONS SHALL BE UL LISTED WEATHER RESISTANT TYPE.

□ SEE ARTICLE 3, COLOR.

A. Small Motor Control Switches:

(1) For small line-to-neutral motor loads of 3/4 HP or less, single phase, rated at 120 or 277 volts, provide snap-type, H.P. rated motor starter switch with thermal overloads. Overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere. All manual starters in finished areas shall be in flush-mounted enclosures.

3. COLOR

A. Color of devices shall be as selected by the architect. Samples (devices, plates or both) may be required to be submitted with other architectural color items by the Contractor. The Contractor shall coordinate any such submission required with other trades, the Prime Contractor or as needed.

B. Where devices are controlling or supplying emergency power from a standby source, the device color shall be red, as with switch toggles or receptacle fronts. Plate color shall match others on normal power in the building unless otherwise noted.

C. Where surface finishes next to the devices vary in color or shade throughout the project, the Contractor may be required to provide lighter or darker plates and devices to more closely match wall finishes. These variations are considered to be included in the original contract for construction.

4. PLATES AND COVERS

A. Unless otherwise specified or noted, all wiring device plates and covers shall be smooth thermoplastic, Hubbell "P" Series or equivalent G.E. or Leviton. Color shall match device unless otherwise indicated.

B. All kitchen, gymnasium or food service area plates shall be bright finish 302 stainless steel.

C. Cover plates shall be of one manufacturer insofar as possible.

D. Weatherproof plates for G.F.C.I. receptacles shall be cast aluminum, self-closing, gasketed, suitable for standard box mounting, U.L. listed for wet location use, cover closed. Vertical mounting - Hubbell WP26M, horizontal mounting - Hubbell WP26MH (die-cast zinc) or equivalent Leviton or G.E.

E. Weatherproof switch plates for toggle-handle switches shall be clear silicone rubber, for standard outlet boxes. Hubbell 1795 or equivalent G.E. or Leviton.

F. Cover plates for computer, telephone or other system outlets shall be as required to meet supplier or the owner's requirements, as applicable. Color to match other plates on project. Furnish telephone plates with wall-mounting studs if mounted at 48" or higher. See devices schedule below.

5. STANDARD SINGLE-SERVICE FLOOR BOXES

A. In general, floor boxes to be used flush in concrete floors shall be of single-gang stamped steel construction, round, deep style, fully adjustable Hubbell B-2537 Series, Type 1 or equivalent.

B. Where multiple gangs are indicated on the plans (or elsewhere), multi-gang (up to 3 yokes maximum) stamped steel, rectangular, deep style units shall be used. They shall be fully adjustable, Hubbell B-2432 Series, Type 1, or equivalent. Multiple-gang boxes shall be provided with removable partitions between each section in accord with N.E.C., where power and non-power circuits enter the same box.

C. In general, all cover plates for floor boxes shall be flush, solid brass. Provide typical plates as listed:

Duplex Outlet	- Round, Duplex Flap - Hubbell S-3925 - Rectangular, Duplex Flap - Hubbell S-3825
Telephone or Data	- Round, Combination 1" or 2 1/8" - Hubbell S-2725 -Rectangular, Combination 1" or 2 1/8" - Hubbell S-2625

D. Furnish floor boxes with threaded hubs as required to suit conduit routings, 3/4" minimum.

E. Furnish carpet flanges for all boxes installed in carpeted areas. Flanges to be clear polycarbonate plastic, round - Hubbell S-3079 or rectangular, for gangs indicated - Hubbell S-308 Series or equivalent.

F. Floor outlet boxes shall be installed dead level flush with wood, VCT, concrete or other hard surface type floor. Furnish special stop trims for terrazzo where required.

G. Outlets within floor boxes shall be as specified elsewhere in these specifications.

6. SPECIAL MULTI-SERVICE FLOOR BOXES

A. In general, floor boxes that are to contain multiple services such as power, data, voice, video, etc., shall be constructed of stamped steel and heavy thermoplastic with barriers or compartments to separate power from signal services per National Electrical Code.

B. Provide multi-service floor boxes with proper trim for carpet, wood, terrazo, tile or concrete floors, wiring slots, dust covers and proper device plates to hold outlets, jacks, etc. They shall be fully adjustable. Conduit rough-in shall be as required. All tops shall be capable of receiving an insert of the surrounding floor material.

C. Outlets for multi-service floor boxes shall be as specified elsewhere in these specifications.

D. Set boxes dead level with flooring and provide proper support by thickening concrete slab, welding angle iron across joists below or other approved means.

E. Multi-service floor boxes shall be capable of containing a minimum of two duplex receptacles and two 4-position single gang modular plates for voice, video or data jacks and shall be as

manufactured by Hubbell #HBLCFB401 base with #HBLTCGNT cover, with all required accessories or equivalent Walker “RFS” Series or Lew. If not installed on carpeted floors, provide flush brass trim.

7. INSTALLATION

A. All wiring devices in dusty areas, exposed to weather and moisture shall be installed in Type "FS" or similar conduit fittings having mounting hubs, with appropriate cover plates.

B. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed.

C. Provide G.F.C.I. duplex feed-thru style receptacles in accordance with new U.L. Standard 943 where indicated or required by the National Electrical Code, whether specifically called out or not. When a G.F.C.I. receptacle is on a circuit with other non-G.F.C.I. receptacles, it shall always be placed at the homerun point of the circuit and shall be wired to ground-fault interrupt protect the downstream outlets on that circuit unless specifically indicated to the contrary. Provide a "G.F.C.I. protected" label on each downstream outlet.

D. GFCI devices shall be installed in a “readily accessible” location per NEC requirements. GFCI protected outlets required by plans or code shall be fed by a GFCI breaker or upstream GFCI device if they are not readily accessible.

E. Where surge suppression outlets are provided, they shall be ANSI Category "A" style. They shall be installed as dedicated-circuit outlets or where indicated with multiple outlets on a circuit, they shall be placed at the homerun point of that circuit and feed-thru wired to protect the downstream outlets on that circuit.

F. All receptacles shall be installed with ground prong at **top** position.

G. All outlets not provided with wiring devices shall be closed with a blank plate matching other plates in the area.

END OF SECTION

SECTION 26 32 13 - EMERGENCY GENERATOR

1. STANDBY GENERATOR SET

   INTENT OF SPECIFICATIONS

   The Contractor shall secure for the purchaser a natural gas engine-generator set of the latest commercial type and design as specified herein.

2. GENERAL

   A. All materials, equipment and parts comprising the units specified herein shall be new and unused, of current manufacturer and of highest grade.

   B. The engine generator set shall contain components as manufactured by Caterpillar, Kohler, Generac, or approved equivalent.

   C. Equipment furnished under this section shall be guaranteed against defective parts or workmanship under terms of the manufacturer's and dealer's standard warranty, of not less than five years. The Contractor shall unconditionally guarantee the installation for a period of one year from the date of final acceptance.

   D. The generator set shall receive the manufacturer's standard factory load testing. Prior to acceptance of the installation, equipment shall be tested to show it is free of any defects, will start automatically and shall be subjected to full building load for a period not less than four hours.

   E. On completion of the installation, start-up shall be performed by a factory trained dealer service representative. Operating and maintenance instruction books shall be supplied upon delivery of the unit. Maintenance and operation procedures shall be explained to the satisfaction of the operating personnel. A full set of brochures shall be provided and stored at the generator installation.

   F. The generator set supplier must have the ability, from within his own operation, to service the engine, generator, automatic transfer switch and all auxiliary components, regardless of how major the repair. He must have local service available from within his own organization not more than five hours driving time from the installation site.

3. GENERATOR SET CHARACTERISTICS

Standby KW	350 KW
Standby KVA	437.5 KVA
Engine Rating Conditions	29.38 HG and 85°F
Power Factor at Specified KW	0.8%
Frequency	60 HZ
Maximum Ambient Temperature Rating	110°F
Minimum Ambient Temperature Rating – Outdoor	Minus 20°F

Minimum Ambient Temperature Rating – Indoor .....30°F
All Ratings Shall Be Certified at 1800 RPM for Engine and Generator

A. The specified standby KW shall be for continuous electrical service during interruption of the normal utility source.

B. The ratings must be substantiated by manufacturer's standard published data. Special ratings or maximum ratings are not acceptable. The specified rating shall be the net KW available after deducting all engine driven accessories.

C. The generator output voltage shall be 480/277/3 phase-4 wire.

D. Gear reduction devices coupling the engine and generator shall not be used. The engine shall be directly coupled to the generator, in a 1:1 ratio.

4. ENGINE

A. The engine governor shall maintain isochronous frequency regulation of 0.25%, plus or minus, from no-load to full load condition.

B. The engine generator unit shall be mounted on a structural steel sub-base and shall be provided with suitable vibration isolators between generator set frame and the base mounting rails. The generator set shall be installed on a minimum 4" high concrete pad that is crowned in the center to permit full drainage from beneath the unit. It shall be securely fastened to the pad in a manner as approved by the generator set manufacturer. The concrete pad shall extend at least six inches beyond the generator outline or housing in all directions. For outdoor installations, the concrete pad shall extend 24" beyond the housing at access panels opening to control panels or equipment points requiring service.

C. Safety Devices - Safety shutoffs for high coolant temperature, low coolant levels, low oil pressure, overspeed, and engine overcrank shall be provided.

D. Lube oil shall be premium quality, furnished by the generator set supplier, as recommended by the engine manufacturer.

5. GENERATOR

A. The generator (AC Alternator) shall be a 3 phase, 60 Hz, single bearing, synchronous type with brushed exciter and be built to NEMA Standards. Class "F" insulation shall be used on the stator and rotor, and both shall be further protected with 100% epoxy impregnation and an overcoat of resilient insulating material to reduce possible fungus and/or abrasion deterioration.

B. A generator mounted regulator shall be provided to match the characteristics of the alternator and engine. Voltage regulation shall be ± 2% from no load to full rated load. Readily accessible voltage level controls shall be provided. Voltage level adjustment shall be a minimum of ± 5%. The regulator shall be of the solid state type, compatible with and configured to control the

engine properly in the presence of S.C.R. and other types of harmonic-producing electrical loads. The alternator shall contain a permanent magnet exciter to sustain a short circuit of 250% for ten seconds.

6. COOLING SYSTEM

   A. An engine mounted radiator with a blower type fan shall be sized to maintain full rated load safe operation at 110°F maximum ambient temperature. The radiator shall be equipped for a duct adapter flange. Air flow restriction from the radiator shall not exceed 1/2" water column or the maximum allowable per shop drawings, if less. For units provided without factory enclosure, the Contractor shall provide ductwork with flexible connecting sections between the radiator duct flange and exhaust damper. All sheetmetal work shall be in compliance with the current edition of SMACNA, installed by skilled tradesmen.

   B. The engine cooling system shall be filled with a solution of 50% ethylene glycol and 50% potable water.

7. FUEL SYSTEM

   A. The entire fuel system installation shall be installed in accordance with local, state and other governing regulations. The entire system shall be inspected and approved by the governing authority. The piping system shall be installed by qualified, approved mechanical tradesmen.

8. EXHAUST SYSTEM

   A. Provide a side inlet critical type silencer with aluminized coating, including an engine-mounted stainless steel corrugated flexible exhaust element. Use stainless steel hardware to fasten these components together and to the engine block.

   B. For outdoor engine/generator installations with enclosures, the silencer shall be mounted inside the enclosure, on corrosion-resistant brackets. Orient exhaust direction away from structures and air intakes. Turn outlet pipe up to the vertical with a sweeping bend and provide a rain cap.

9. AUTOMATIC STARTING SYSTEM

   A. A 12 or 24 volt DC electric starting system with positive engagement drive shall be furnished.

   B. Fully automatic generator set start/stop controls in the generator control panel shall be provided. Controls shall provide shut down for low oil pressure, high coolant temperature, low coolant level, overspeed, overcrank with one auxiliary convertible contact for activating accessory items. Controls shall include a thirty second single cranking cycle limit with lockout. Provide interconnecting wiring in conduit to remote annunciator (if specified) as required.

   C. A 12 or 24 volt lead acid storage battery set of the heavy duty starting type shall be provided. The battery set shall be of sufficient capacity to provide for 1 minutes total cranking time without recharging, with sufficient amp hour rating to suit the engine selection. A corrosion-

resistant battery rack, necessary cables and clamps shall be provided. Provide connection using THWN wiring in conduit to battery charger, as required.

D. For outdoor installations, provide battery warming pads rated at 120 volts input, in accord with the battery manufacturer's recommendations. Provide normal power 120 volt circuit as required.

E. A current limiting automatic two rate battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicone diode full wave rectifiers, voltage surge suppressors, DC ammeter, and fused AC input. AC input voltage shall be 120 volts. Provide emergency generator powered circuit as required. Amperage output shall be no less than ten amperes.

F. A unit mounted thermal circulation type water heater(s) controlled by a thermostatic switch shall be furnished to maintain engine jacket water to 120°F. in an ambient temperature of 0°F. Provide for 120 or 208 volt, single phase operation, per manufacturer's recommendation. Provide normal utility source power circuit as required.

10. GENERATOR CONTROL PANELS

A. A generator mounted NEMA 1 type vibration isolated dead front control panel constructed of code gauge steel shall be provided.

B. Control panel shall contain, but not be limited to the following equipment:

1) Voltmeter, analog gauge, 2% accuracy
2) Ammeter, analog gauge, 2% accuracy
3) Voltmeter and Ammeter phase selector switch
4) Frequency meter, analog or vibrating reed type, 2% accuracy
5) Automatic starting controls as specified
6) Panel illuminating lights and test switch
7) Voltage level adjustment rheostat
8) Engine oil pressure gauge
9) Engine water temperature gauge
10) Contacts for remote alarms wired to terminal strips
11) Fault indicators for low oil pressure, high coolant temperature and low coolant level, overspeed and overcrank
12) Multi-position function switch with "Auto", "Manual", "Off/Reset" positions
13) Engine running elapsed time meter, cumulative, non-resettable Emergency stop switch, with local audible alarm

C. Digital metering may be substituted for analog style gauges, at the Contractor's option.

11. MAIN LINE CIRCUIT BREAKER

A. A generator mounted main line molded case circuit breaker of 300A, 200A, and 100A amps shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short circuit conditions.

B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriter's Laboratories, National Electric Manufacturer's Association and National Electrical Code.

C. Generator exciter field circuit breakers are unacceptable when utilized for line protection.

12. AUTOMATIC TRANSFER SWITCH

A. Automatic transfer switch(es) shall be furnished as shown on the drawings and specified below. Switch shall be capable of switching all classes of loads and shall be rated for continuous duty when installed in a non-ventilated enclosure. Enclosures shall conform to UL and NEMA standards.

B. The transfer switch shall be double throw, inherently interlocked mechanically and electrically, actuated by a single electrical operator which is momentarily energized. The switch shall be capable of transferring successfully in either direction with 70% of rated voltage and shall be mechanically held.

C. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Mechanical interlock shall be separate from operating mechanism, providing positive interlock in the event of operator failure. Provide mechanism external to cabinet for manual operation of switch.

D. If any phase of the normal source drops below 70% of rated line voltage, an engine start contact shall close to start the generating plant after the specified time delay. The transfer switch shall transfer to the emergency source after the alternator voltage and frequency have reached 90% of rating. After restoration of normal power on the normal source, retransfer to normal shall occur with delay set at five minutes, adjustable from zero to thirty minutes.

E. As a precondition for approval, all switches, complete with timers, relays and accessories shall be listed by UL under Standard UL 1008 Automatic Transfer Switches and shall be approved for use on emergency power systems per NFPA and all applicable codes.

F. Transfer switch ratings and accessories shall be as follows:

300 amp ATS-2
480 volts
3 phase
4 wire
60 Hz
4 pole
Wall mounted
Totally enclosed, NEMA 1
65,000 AIC rating
Ground bar, bonded to enclosure

200 amp – ATS-1
480 volts
3 phase
4 wire
60 Hz
4 pole
Wall mounted
Totally enclosed, NEMA 1
65,000 AIC rating
Ground bar, bonded to enclosure

100 amp – ATS-3
480 volts
3 phase
4 wire
60 Hz
4 pole
Wall mounted
Totally enclosed, NEMA 1
65,000 AIC rating
Ground bar, bonded to enclosure

G. Transfer Switch Accessories:

(1) Time Delay for engine start on utility failure, factory set at 3 seconds, adjustable 1-60 seconds.

(2) Adjustable time delay on retransfer to normal (motor driven type - 0 to 30 minutes, set at five minutes, arranged for five minute unloaded running time for standby plant cooldown).

(3) Close differential relay protection on normal, using 3 phase, 4 wire relays when are factory set for 90% pick-up, 70% dropout. Relays shall be adjustable.

(4) Test switch to be mounted on cabinet - to provide for load, no-load and off-line, operation of emergency plant and transfer switch.

(5) Auxiliary contact to close when normal power fails (pilot contact to initiate starting controls on engine).

(6) Pilot lights for indicating switch in emergency (red) and normal (green) position.

(7) Two auxiliary contacts, 300 volt, 20 amp rated, on main shaft (closed on normal).

(8) Two auxiliary contacts, 300 volt, 20 amp rated, on main shaft (closed on emergency).

(9) Enclosures to be NEMA 1, or NEMA 3R, if outdoors.

(10) Frequency relay - To prevent transfer to emergency until voltage and frequency of generating plant have reached 90 percent of rating.

(11) Retransfer phase protection – The switch shall be equipped with an in-phase relay or delayed (programmed) transition feature to prevent out-of-phase switching. All settings shall be adjusted per manufacturer's recommended practice prior to energizing switch.

13. ANNUNCIATOR PANEL

A. A fully flush-mounting trim panel shall be provided for remote mounting to give audible and visual warning of fault of alarm conditions in the generator set. The panel shall conform with the requirements of the National Electrical Code, Section 700-12, and the National Fire Protection Association Publication NFPA 99 (NFPA 110 in health care installations). All necessary contacts shall be provided. Locate as shown on plans or as directed by the Engineer and connect in accordance with shop drawing requirements.

14. WEATHERPROOF ENCLOSURE

A. Provide a Level 2 Sound Attenuation weatherproof, corrosion-resistant outdoor housing to enclose the entire generator set. Enclosure shall be provided with tamper-resistant hardware and shall have lockable (keyed alike) access panels for access to all major components.

B. Enclosure shall be painted a color as approved by the Architect and/or the Engineer, selected from manufacturer's standard colors.

C. The enclosure shall be the standard product of a manufacturer that is represented by the generator set supplier.

END OF SECTION

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SECTION 26 43 13 - SURGE SUPPRESSION SYSTEMS

1. GENERAL

   A. Each Contractor's attention is directed to Section 26 05 01, General Provisions - Electrical and all other contract documents as they may apply to his work.

   B. Each Surge Suppression Unit (transient voltage surge suppressor, or T.V.S.S.) furnished shall meet or exceed U.L. 1449, Second Edition *Revision* (February 2007), with capacity for each basic Category A, B and C, surge rise time of ten microseconds and a surge duration of at least one thousand microseconds.

   C. SPECIAL NOTE: When using a "Meggar" or similar instrument to test conductors in a panelboard or switchboard, disconnect any T.V.S.S. device connected to any combination of those conductors. Failure to do so may damage or destroy the T.V.S.S. device. If any damage occurs as a result of testing to a T.V.S.S. device, the Contractor shall replace the device.

2. SCOPE OF THE WORK

   A. The Contractor shall provide the necessary labor, materials, wiring and services necessary to provide the complete electrical surge protection systems as specified herein. This work shall include, but is not necessarily limited to:

      (1) Provision of Surge Suppression Units at certain points in the power distribution network, on telephone, satellite dish leads and cable television service lines as indicated herein or on the drawings.

      (2) Proper installation of surge suppression unit(s), in accord with shop drawings. Wiring routing, grounding, raceways and all connections shall be in exact accord with manufacturer's recommendations, the National Electrical Code, and any other applicable regulations, local or national, or international.

3. QUALITY ASSURANCE

   A. The manufacturer shall be regularly engaged in production of surge protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than three years.

   B. Comply with NEC and NFPA requirements, as applicable to materials and installation of surge protection components and wiring. Surge protection equipment shall be UL listed and labeled for its intended use. TVSS shall be labeled with 200kA Short Circuit Current Rating (SCCR). Where applicable, equipment shall comply with ANSI standards for such equipment.

   C. SPECIAL NOTE: The physical routing, length and connections of the unit's phase, neutral and ground conductors are critical to the performance of surge suppression units. The Contractor shall carefully observe and comply with the manufacturer's installation requirements.

4. SUBMITTALS

A. Product Data: Submit manufacturer's data on surge protection systems and components as part of shop drawing submissions. Indicate all capacity ratings, clamp times, maximum capacities, EMI/RFI attenuation data, withstand capabilities, physical construction and listing agency approvals.

B. Maintenance Data: Submit maintenance instructions for surge suppression system. Include this data in Operation and Maintenance manuals.

5. MATERIALS

A. ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering surge protection components which may be incorporated in the work includes, but are not limited to, the ones listed below. Other manufacturers will be considered if their proposed products are in full compliance with these specification requirements.

Surge Protective Devices:

Liebert Corporation, Inc
General Electric Corporation
Transtector, Inc.
Advanced Protection Technologies, Inc.
Square D. Inc.

6. T.V.S.S. MINIMUM REQUIREMENTS

T.V.S.S. minimum requirements shall meet or exceed the following criteria:

A. Minimum surge current capability (single pulse rated) per phase shall be:

(1) Service entrance applications: 200 kA per phase (Category “C”)
(2) Distribution applications: 120 kA per phase (Category “B”)
(3) Non-receptacle applications: 40 kA per phase (Category “A”)
(4) Receptacle applications: 12 kA per phase (Category “A”)

B. UL 1449 Listed Suppression Voltage Ratings for service entrance shall not exceed the following: (Category “C”)

VOLTAGE	L-N	L-G	N-G	MCOV
208Y/120V	400	400	400	150V
240Delta/120V	400	400	400	150V
480Y/277V	800	800	800	320V

(With internal disconnect switch 400V and 800V respectively).

C. UL 1149 Listed Suppression Voltage Ratings for distribution shall not exceed the following: (Category "A" & "B")

VOLTAGE	L-N	L-G	N-G	MCOV
208Y/120V	400	400	400	150V
240Delta/120V	400	400	400	150V
480Y/277V	800	800	800	320V

(With internal disconnect switch 400V and 800V respectively)

(L-N = Line to neutral)
(L-G = Line to ground)
(N-G = Neutral to ground)
(MCOV = Maximum continuous operating voltage)

7. BUILDING ELECTRICAL SERVICE SURGE PROTECTION SYSTEM COMPONENTS

A. GENERAL

(1) Provide UL 1449 Second Edition *Revision* (February 2007) listed and labeled lightning and transient surge protection devices, installed where shown on the drawings and in accord with the manufacturer's recommendations.

(2) The surge protection devices shall be shunt type and polyphase, with the ability to conduct high energy transients from line to ground, line to neutral and neutral to ground. Provide in a NEMA 12 enclosure with hinged or screw cover front panel. Provide internal fusing in modules to protect unit.

(3) Provide units with EMI/RFI noise attenuation, using 50 ohm insertion loss test: -50 dB at 100 khz, UL 1283 listed, with an insertion ratio of 50:1 using M.I.L. STD 220-A.

(4) For each surge suppression unit, categories A, B & C, provide unit function status indicators. These indicators shall be mounted in the face of the equipment panel. Provide green L.E.D., illuminated for normal operation, red L.E.D. for trouble/fault or reduction of surge suppression capacity. Provide an audible alarm with silence switch to alarm at unit on malfunction for category "C" units only. Provide a resettable surge counter for each category "C" unit to indicate each suppression operation of the unit.

(5) Enclosures shall be surface-mounted where panels protected are surface-mounted, flush-mounted for all units in finished areas. Where panels protected are flush-mounted, place surge suppression device above or below panel, aligned and square with panel trim.

(6) Provide disconnecting means for each surge protection device per the following:

Category "C" Device at Main Service:
40 to 60 Ampere, 3 Pole, 600V, S/N, NEMA 1 disconnect, built into the unit and furnished by the supplier as an integral part of the equipment. Disconnecting means shall be capable of withstanding the available fault currents. Verify fault current with the Contractor.

Category "B" Devices, at Panels:
30 Ampere, 3 Pole Circuit Breaker in Protected Panel

Category "A" Devices, at Panels:
30 Ampere, 3 Pole Circuit Breaker in Protected Panel

(7) Internal Device Overcurrent Protection (Fusing)

a. All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I^2t capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. Every suppression component of every mode (including Neutral to Ground) shall also be protected by thermal overtemperature controls. If the rated I^2t characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 KA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored, to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.

B. MAIN SERVICE SURGE SUPPRESSION - CATEGORY "C" UNITS

(1) Category "C" units shall be installed on the service entrance or building entrance equipment. Units shall be rated 277 volts/480 volts (or 120/208 volts as needed), 3 phase, 4 wire, minimum 200,000 amp (total amps per phase) surge capacity, with less than 5 nanosecond reaction time. Category "C" units installed to protect a switchboard may be built into the switchboard construction if U.L listed for such applications.

(2) Category "C" withstand capabilities: 5,000 A.N.S.I. Category C3 surges with less than 10% change in clamping voltage.

C. PANELBOARD SURGE SUPPRESSION - CATEGORY "B" UNITS

(1) Units shall be installed as indicated herein or on the contract drawings, set beside or above the distribution panel indicated, and connected as recommended by the equipment manufacturer.

(2) All emergency system switchgear, distribution panels and branch panelboards shall be provided with surge protection devices in accordance with the NEC.

(3) Category "B" units shall be rated for 277-480 volts (or 120/208 volts, as indicated), 3-4 Wire Wye service. Units shall be minimum 120,000 ampere rated per phase, with less than 5 nanosecond reaction time. Provide fusing and fault indicator pilot lights as in (A) - General above.

(4) Category "B" withstand capabilities: 5,000 A.N.S.I. Category C3 surges with less than 10% change in clamping voltage.

D. BRANCH PANELBOARD SURGE SUPPRESSION - CATEGORY "A" UNITS (NON-RECEPTACLE APPLICATIONS)

(1) Units shall be installed as indicated herein or on the contract drawings, set beside or above the panelboard indicated, and connected as recommended by the equipment manufacturer.

(2) All emergency system switchgear, distribution panels and branch panelboards shall be provided with surge protection devices in accordance with the NEC.

(3) Units shall be installed flush in finished areas. Units may be surface-mounted if in unfinished mechanical spaces and the panel protected is also surface-mounted.

(4) Category "A" units shall be rated for 277/480 volts or 120/208 volts, three phase, 4 wire wye service as indicated on the drawings. Units shall be rated 40,000 amperes surge current, less than one nanosecond response time. Units shall be fused in accord with (A) - General noted above.

(5) Furnish unit with red and green indicator lights to signify normal operation and component or suppression capability failure.

E. TELEPHONE AND TELEVISION SURGE SUPPRESSION

(1) As a part of this section of work, the Contractor shall provide or arrange for the installation of U.L. listed lightning and surge arrestors on the incoming telephone and television service lines, as well as on AM-FM- antenna downleads and the coaxial cables coming into the building from satellite dish antennas and all other types of exterior antennas installed by the Contractor or Owner, where the Contractor installs the coaxial cable for the antenna.

(2) Arrestors shall be U.L. listed, properly grounded per N.E.C., and shall be located at the service entrance points for each cable installed by a utility company or at the point of building entry for Contractor-installed cables leading in from antennas. Also provide surge arrestors of the proper type for any copper cables that are installed between buildings by the Contractor, if such a condition occurs within the project.

(3) The Contractor shall arrange for the telephone company to install M-O-V, gas-type or other U.L. listed lightning arrestors on each of their incoming telephone circuits that are terminated for building use.

(4) Arrestors for coaxial lines shall be rated 25 to 250 MHZ on cable T.V. lines, and 250 MHZ to 1GHZ on satellite dish lead-ins with BNC jacks in/out or as required by antenna connectors.

(5) Devices as manufactured by Lucent Technologies, Winegard or Liebert Corporation will be acceptable.

(6) Provide a ground lug for individual surge suppression unit installations, with the recommended ground wire size routed back to the building main electrical ground or ground bar in wiring closet.

(7) Where multiple surge suppression units are installed, as at service entrance locations, provide a ground bar, copper, with multiple tapped holes and a properly sized ground lead routed back to the building main electrical ground.

8. EXECUTION

A. Installation of Surge Protection Systems:

(1) Install surge protection systems as indicated and in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA, local prevailing codes and with UL lightning and power surge protection standards to ensure that surge suppression systems comply with requirements.

(2) Coordinate with other work, including electrical wiring work as necessary to interface installation of units.

(3) Install conductors with direct, shortest possible phase, neutral and ground paths from all in/out connections, avoiding sharp bends and narrow loops.

(4) Install surge suppression units as close as practical to equipment they are protecting. Install appropriate units at main electrical service entrance equipment and secondary branch panelboards as indicated.

(5) Refer to the drawings for installation of individual surge suppression devices to protect branch circuits. Also see Section 26 27 26 for (receptacle type) device requirements. All receptacle type surge suppression units shall be wired as feed-thru type, to protect all downstream outlets on that branch circuit unless otherwise indicated.

9. WARRANTIES

A. All surge suppression equipment shall be unconditionally warrantied by the Contractor for a period of one year from the date of project substantial completion. Where longer manufacturer's warranties are offered, they shall be made available to the Owner. Note these extended warranties in the Operations and Maintenance Manuals.

B. Category "C" devices to carry 5 year parts and on site labor unconditional warranty.

C. Category "B" and "A" devices to carry 5 year unconditional replacement warranty.

END OF SECTION

SECTION 26 51 13 - LIGHTING FIXTURES AND LIGHTING EQUIPMENT

1. GENERAL

A. Furnish and install all lighting fixtures, as herein specified, complete with accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections, apply to this Section.

C. All items furnished shall comply with the latest standards applicable such as U.L., NEMA, etc., and shall bear labels accordingly. All fixtures shall be the color specified or as selected by the Architect. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or fingerprints shall be restored to new condition or shall be replaced.

D. Shop drawings shall be submitted electronically – refer to Division 01. As part of shop drawings provide drawing illustrating interior lighting controls and shading. As part of LEED submittal for SS Credit 8, provide manufacturer's data for exterior lighting, including data on initial fixture lumens above 90 degrees from nadir for all exterior lighting fixtures, and for parking lot lighting, verification that the fixtures are classified by the IESNA as 'full cutoff' (FCO), OR provide documentation that exterior luminaires are IDA-Approved as Dark-Sky Friendly by the International Dark Sky Association (IDA) Fixture Seal of Approval Program. Additionally, provide a description of the light trespass analysis and photometric site plan that includes a footcandle summary table.

E. Locate pendant, surface mounted or chain-hung industrial fixtures in mechanical rooms and similar spaces to avoid ductwork and piping. Locate around and between equipment to maximize the available light. Request a layout from the Engineer if uncertain about an installation.

F. Refer to drawings for acceptable manufacturers. Proposed substitutions must be submitted per Division 00 and Division 01.

G. All reflecting surfaces, glass or plastic lenses, downlighting Alzak cones and specular reflectors shall be handled with care during installation to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

H. Refer to architectural details as applicable for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades.

Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

I. Warranty shall start at Final Project Completion.

2. VOLTAGE

A. All lighting fixtures will be rated 277 volts, single phase as indicated or required.

3. LED FIXTURES

LED SOURCES

A. LED's shall be manufactured by a manufacturer who has produced commercial LEDs for a minimum of five (5) years.
B. Lumen Output – minimum initial delivered lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-360 degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.
C. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours at the rated ambient operating temperature.
D. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
E. LED Boards shall be suitable for field maintenance and have with plug-in connectors. LED boards shall be upgradable
F. Light Color/Quality:
    a) Correlated Color temperature (CCT) range as per specification, between 3000K, 3500K and 4000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
    b) Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.
    c) The color rendition index (CRI) shall be 80 or greater
    d) LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

LED DRIVERS

A. Driver: Acceptable manufacturer: eldoLED, Sylvania, or Philips that meet or exceed the criteria herein.
B. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
C. Driver should be UL Recognized under the component program and shall be modular for simple field replacement.
D. Electrical characteristics: 120 – 277 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.

E. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 percent to 0.1 percent of rated lumen output with a smooth shut off function.
F. Dimming shall be controlled by a 0-10V signal, or if require "DMX".
G. Driver shall include ability to provide no light output when the control signal drops below 0.5 V, and shall consume 0.5 watts or less in this standby.
H. Driver shall be capable of configuring a linear or logarithmic dimming curve.
I. Drivers shall track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range regardless of the controller type
J. Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have: Less than 1 percent flicker index at frequencies below 120 Hz and less than 12 percent flicker index at 120 Hz, and shall not increase at greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz
K. Driver disconnect shall be provided where required to comply with codes.

LED ELECTRICAL

A. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements.
B. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A. To reduce false circuit breaker tripping due to turn on inrush, the following statement ensures that electronic dimming driver will meet NEMA inrush recommendations.
C. Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps2 – seconds.
D. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions
E. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance.
F. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

4. LIGHTING FIXTURE SCHEDULE

A. Refer to the contract drawings for Lighting Fixture Schedule

5. PHOTOCELLS

A. Provide photocell as part of network lighting control system.

B. Mount photocells in locations concealed from sight lines standing on ground unless otherwise noted, in which case the final position shall be as directed by the Architect. Group together (if indicated at one location) and mount on back of parapet wall or otherwise properly support with mounting bracket. Coordinate with roofing installer to ensure that roof penetrations are properly made without violating or reducing the roof warranty in any way. Photocells may be mounted in other locations if it is not practical to install them on roofs or parapets, in which case the Contractor shall request direction for their mounting locations from the Engineer or Architect. Photocells shall always be mounted in a weatherproof, inconspicuous manner.

C. Photocell shall be connected to network lighting control system for normal control of all building mounted and site lighting – refer to plans for locations.

6. TIMECLOCKS

A. Provide timeclock function as part of network lighting control system.

END OF SECTION

SECTION 26 51 16 - NETWORK LIGHTING SYSTEMS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (occupancy), and manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed)

C. The system architecture shall provide stand-alone groups (rooms) of devices to function in a default capacity even if network connectivity to the greater system is lost. The network shall allow for remote troubleshooting and reporting as well as some higher level functionality.

D. The system shall not require any centrally hardwired switching equipment.

E. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

F. Graphical floor plan software shall be provided allowing the owner to see devices in specific rooms and by clicking on the symbol with a mouse shall be able to see status, make device adjustments, modify schedules, over-ride, and/or disable devices. The software shall also provide a reporting tool that indicates what savings have been accomplished by use of each technology used in a space over a specified time (Occupancy sensing, daylight harvesting, time of day, etc.)

1.4 SUBMITTALS

A. Product Data: For each type of product.

A. Specification Conformance Document: Indicate whether the submitted equipment:
   A. Meets specification exactly as stated.
   B. Meets specification via an alternate means and indicate the specific methodology used.

B. Shop Drawings; include:
   A. Schematic (one-line diagram) of system.
   B. Mounting dimension requirements for each product and mounting condition.

C. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements for all switches, relays, sensors, equipment part of the lighting system.

D. Sequence of Operation to describe how each area operates and how any building wide functionality is described.

E. Sequence of Operation to describe how each area operates and how any building wide functionality is described.

F. Provide coordination drawings showing interconnecting control wiring and interface devices.

G. Quality Control Submittals:
   A. Test Reports: Indicating compliance with specified fabric properties.
   B. Certification: Morton International Laboratory Report for PVC coated fabrics and bacterial and mildew resistance.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and 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.

1.6 QUALITY ASSURANCE

A. Retain "Testing Agency Qualifications" Paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article. Qualification requirements are in addition to those specified in Section 01 40 00 "Quality Requirements," which also defines "NRTL" (nationally recognized testing laboratory).

B. All steps in sensor manufacturing process shall occur in the USA; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.

C. All components and the manufacturing facility where product was manufactured must be ROHS compliant.

D. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

E. All applicable products must be UL/CUL Listed or other acceptable national testing organization.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation according to NECA 407.

1.8 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of

compatible components.

B. Coordinate lighting controls with BAS (if necessary) either through IP based intercommunication of system or hardwired auxiliary relay outputs.

C. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.9 WARRANTY

A. All devices in lighting control system shall have a 5 year warranty. Warranty shall start at Final Project Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. This specification is based on the nLight Network Control System from Sensor Switch, by Watt Stopper or Cooper Controls

2.2 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section)

D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and posses RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5E low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.

N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.

O. WiFi-enabled devices shall be capable of current monitoring

P. WiFi-enabled devices shall utilize WPA2 AES encryption

Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks

R. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi- enabled system devices

S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

T. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

U. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.

V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

W. A taskbar style desktop application shall be available for personal lighting control.

X. An application that runs on “smart” handheld devices (such as an Apple® IPhone®) shall

be available for personal lighting control.

Y. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

Z. Control software shall enable integration with a BMS via BACnet IP.

AA. System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Control Module (Gateway)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet. Provide Network connection from building as needed at head end - Coordinate with low voltage installer.

2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.

3. Control device shall have three RJ-45 ports for connection to other backbone devices
(bridges) or directly to lighting control devices.

4. Device shall automatically detect all devices downstream of it.

5. Device shall have a standard and astronomical internal time clock.

6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.

7. Device shall have a USB port

8. Each control gateway device shall be capable of linking 1500 devices to the management software.

9. Device shall be capable of using a dedicated or DHCP assigned IP address.

B. Networked System Occupancy Sensors

1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.

4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable. Provide this type of sensor in all group restrooms.

5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

6. Sensors shall be include two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.

7. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.

8. Sensors shall be available in multiple lens options which are customized for specific applications.

9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue

12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.

14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.

15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire

connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

17. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.

18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray). Wall plates shall be brushed stainless steel

19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls

20. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.

21. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection

22. Embedded sensors shall have an optional photocell

23. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.

24. Fixture mount sensors shall be capable of powering themselves via a line power feed.

25. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

26. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).

27. System shall have WiFi enabled fixture mountable sensors available.

28. Embedded sensors shall have an optional photocell and 0-10 VDC dimming output

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA

of class 2 current (typically 40 or more ballasts).

5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)

6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.

7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.

9. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.

D. Networked System Metering Power (Relay) Packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system and come capable of metering connected load.

3. All devices shall have two RJ-45 ports.

4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.

5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

7. Power Packs and Power Supplies shall be available that are WiFi enabled.

8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.

9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.

10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.

11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.

13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.

14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.

15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.

16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.

17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.

18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.

2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.

3. Panel shall provide one 0-10VDC dimming output paired with each relay.

4. Panel shall power itself from an integrated 120/277 VAC supply.

5. Panel shall be capable of operating as either two networked devices or as one.

6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.

7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection

F. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.

2. Devices shall have two RJ-45 ports

3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).

5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.

6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output

7. Specific I/O devices shall sense state of low voltage outdoor photocells

8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

9. Specific I/O devices shall sense.

G. Networked LED Luminaires

1. Networked LED luminaire shall have a mechanically integrated control device

2. Networked LED luminaire shall have two RJ-45 ports

3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)

4. Networked LED luminaire shall provide low voltage power to other networked control devices

5. System shall be able to turn on/off LED luminaire without using a relay

6. System shall be able to maintain constant lumen output over the specified life of the LED luminarie (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).

7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.

2. Devices shall be available with zero or one integrated Class 1 switching relay.

3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

4. All sensors shall have two RJ-45 ports.

5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.

6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).

7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).

8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.

9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.

10. Devices with mechanical push-buttons shall be made available with custom button labeling

11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

I. Networked System Graphic Wall Station

1. Device shall have a 3.5” full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.

2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.

3. Device shall enable user supplied .jpg screen saver image to be uploaded.

4. Device shall surface mount to single-gang switch box

5. Device shall have a micro-USB style connector for local computer connectivity.

6. Device shall have two RJ-45 ports for communication

J. Networked System Scene Controllers

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

2. Device shall recess into single-gang switch box and fit a standard GFI opening.

3. Devices shall provide LED user feedback.

4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

5. All sensors shall have two RJ-45 ports.

6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.

7. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).

8. Device shall have LEDs indicating current selection.

K. Communication Bridges

1. Device shall surface mount to a standard 4" x 4" square junction box.

2. Device shall have 8 RJ-45 ports.

3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.

4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.4 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control

profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be

encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.7 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual

zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and

schedules.

K. Data shall be made available via a .CSV file

2.8 START-UP & SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels 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

H. Install equipment in accordance with manufacturer’s installation instructions.

I. Provide complete installation of system in accordance with Contract Documents.

J. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

K. Define each dimmer's/relay’s load type, assign each load to a zone, and set control functions.

L. Season lamps at full intensity according to lamp manufacturer’s recommendation.

M. Install equipment in accordance with manufacturer’s installation instructions.

N. Provide complete installation of system in accordance with Contract Documents.

O. Provide equipment at locations and in quantities indicated on Drawings. Provide any

additional equipment required to provide control intent.

P. Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.

Q. Season lamps at full intensity according to lamp manufacturer's recommendation.

R. Install plenum cable in environmental air spaces, including plenum ceilings.

S. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

T. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

U. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate.

3.4 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 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.

C. Acceptance Testing Preparation:

1. Test continuity of each circuit.

D. Lighting control panel will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected,

remedial action taken, and observations made after remedial action.

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. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time- of-day schedules, and input override assignments.

B. Required factory-trained personnel site visits:

1. Pre-installation: The system shall be provided with visits from factory trained technician(s) for a pre-installation visit with the contractor prior to system installation.
2. Commissioning and Programming: A second visit shall be included for commissioning and programming of the system including testing of switches and sensors.
3. Owner Training: A third visit shall be provided for owner training after the owner has occupied the building. Minimum four hour training to be video recorded.
4. Owner Re-Training and System Adjustment: A fourth visit 6 months after the owner has occupied the building shall be provided to tweak the system for occupant preferences and for additional training.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 SEQUENCE OF OPERATION

A. Classrooms:

1. The classrooms shall be provided with a control station at the entry door to turn on and dim the zones of lighting in four (4) presets. The first preset shall be labeled “green” and shall turn all lighting on to 30 footcandles. The second preset shall be labeled “AV” and shall turn the lighting closest to the teaching wall on to 10% output with the rest of the lighting at 30% output. The third preset shall be labeled “Full” with all lighting at 100% output. The fourth preset shall be labeled “Low” and shall be all lighting at 10% output. A vacancy sensor shall be provided to turn lights off when no occupancy has been detected for 30 minutes. It shall include auxillary relay contacts to provide occupancy status to the temperature control system.

B. Corridor/Lobbies/Vestibules:

1. The common areas shall be controlled via occupancy sensors. During school hours the switches will be programmed as on only.

C. Restrooms:

1. The restrooms shall be controlled via occupancy sensors.

D. Storage Rooms:

1. The storage rooms shall be provided with a low voltage switch at the entry door allowing the occupant to turn lighting on if needed. The vacancy sensor shall turn the lighting off when no occupancy has been detected for 5 minutes.

E. Gym:

1. The lighting shall be controlled via low voltage touchscreen at entry doors. Time of day scheduling will put the Gym into occupied mode at 6:00AM and into unoccupied mode at 10:00PM. The occupant will be required to turn the lighting on when they enter the space. When not in use, occupancy sensors will control space. Gym should be provided with multiple levels of zones as seen on drawings. Fixtures shall be connected to photosensors and occupancy sensors and zoned per drawings.

F. Media Center:

1. The media center shall be provided with a touchscreen switch at the entry door to turn on all lighting in one zone. A touch screen master control station shall be provided at the media desk to switch and dim separate zones – see plans for zone locations. Photosensors shall be provided to dim the lighting in daylighting zones independently from the rest of the room. Time of day scheduling shall place the room into occupied mode at 5:30AM and shall sweep lighting off after a blink warning at 6:30PM. Fixtures shall be connected to photosensors and occupancy sensors and zoned per drawings.

G. Cafeteria:

1. The cafeteria shall be controlled via the theatrical lighting system.

H. Kitchen:

1. The kitchen shall be controlled via time of day scheduling. It shall be placed in occupied mode at 4:00AM and unoccupied mode at 6:30PM. At 6:30 the lighting will be swept off after a blink warning to provide occupants time to hit the switch and receive 90 minutes of additional lighting. Switches shall be placed in locations indicated on drawings to provide 90 minute over-ride to on when necessary. During school hours the switches will be programmed as on only.

3.9 SERVICE AND SUPPORT

A. Provide factory certified field service engineer to make minimum of three site visits to ensure proper system installation and operation under following parameters
   a. Qualifications for factory certified field service engineer:
      1) Minimum experience of 2 years training in the electrical/electronic field.

2) Certified by the equipment manufacturer on the system installed.

b. Make first visit prior to installation of wiring. Contractor must schedule meeting Electrical Engineer and Manufacturer representative to review system and functionality prior to installation of wire and equipment.

c. Make second visit upon completion of installation of Network Lighting Control System for system start up. Schedule start up with owner and engineer with 2 weeks prior notice.

d. A total two (2) Owner training session with the electrical contractor, the lighting controls contractor, the factory authorized representative, engineer of record, and the owner (and staff) shall be conducted at the project site. The training session shall be scheduled a minimum of 2 weeks prior. The training session shall not be conducted until the lighting controls system has been programmed and is fully operational.

e. A total of two (2) walk thrus shall be conducted after completion of construction to assure that the system is fully operational. The walk thrus shall be schedule a minimum of 2 weeks prior and shall be conducted at the request of the owner or engineer of record. In lieu of a formal request from the owner or engineer of record the walk thrus shall be conducted 3 months and 9 months after completion of construction. Reports shall be issued at each walk-thru.

END OF SECTION

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SECTION 26 55 61 – THEATER LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide and install complete and operational Theater Lighting System(s) as outlined in these specifications and related drawings and documentation requirements as set forth in this documentation.
   2. Equipment and systems shall be installed at Glenridge Middle School located in Prince George's County Maryland.
   3. It is the responsibility of the Contractor to provide all wiring, plates, connections, equipment, rigging, all support means and miscellaneous equipment for complete and fully operational System(s) if specified in this or other related documents or not.
   4. Included Spaces:
      a. Cafeteria/Stage

B. Provide for the coordination, provision, installation, inspection, testing, instruction, and warranties of the Theater Lighting System(s).

C. Provide all materials, equipment, transportation, and necessary labor for a complete and operational Theater Lighting System(s).

D. Additional contractor requirements:
   1. Required licenses, permits and low voltage permits including any required bonding or insurance requirements to comply with general conditions of specifications and contract documentation.
   2. Verification of the dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturers' recommendations.
   4. Submittal information and provisions.
   5. Instruction of operating personnel.
   6. Manuals and provisions thereof.
   7. Maintenance and warranties.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including, but not limited to, Divisions 0, 1, 11, 26, 16, 27 and the general contract specifications.

B. Related specification sections:
   1. Section 11 61 33 Rigging Systems and Controls
   2. Section 27 41 13 Projection Screens

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.

B. Conduits:

1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.5 DEFINITIONS:

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:

1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
2. The terms "shall" is mandatory, "will" is informative, and "should" is advisory.
3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
7. The term "Professional grade" – Equipment that is intended for commercial use, not residential, use and is rated for continuous 24-7 use.
8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
9. The term "Labels" – refer to labels on cables and equipment as outlined in Section 3.2.
10. The term "OFE" refers to items that are Owner Furnished Equipment
11. The term "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:

1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
    a. International Building Code / BOCA National Building Code
    b. Local Governing Authorities Having Jurisdiction
    c. NFPA-72 National Fire Alarm and Signaling Code
    d. NFPA-70 National Electric Code (NEC)
    e. UL Listed- Underwriter's Laboratories Listed

1.7 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide a fully operational Theater Lighting System(s).
B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.
C. The Contractor shall provide complete and operational system(s) configured and installed for user-friendly operation and low maintenance.
   1. Provide for reprogramming of the remote-control software two (2) times, as directed by the Owner's Representative and or Consultant.
   2. Provide for two (2) adjustments of the Theater Lighting System(s), as directed by the Owner's Representative and or Consultant.
D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.
E. The Contractor shall restore all finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.
F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.
G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.
H. All finalized software affiliated with the equipment is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.
I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM(S) DESCRIPTION AND REQUIREMENTS

A. The following is a basic system(s) description and is not intended to be all-inclusive for proper installation or operation of system(s). The Theater Lighting specification and the Theater Lighting Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.
   1. The Bid proposal will include all labor and cabling for all optional / add alternate equipment listed in Theater Lighting specification and Theater Lighting Bid set drawings. Please list as separate budgetary items.
B. The system shall be designed for the control of architectural and theatrical lighting and shall consist of factory pre-wired dimming and processing rack enclosures containing dimmers, power supplies, breakers, terminals and/or control electronics.
   1. The theatrical lighting system shall have full control of the house lighting system. The house lighting system shall be provided by the electrical contractor.
   2. All programing of the control system including the control of the house lighting system shall be provided by the theatrical lighting contractor.
   3. House lighting provided by the electrical contractor to have individual DMX connections at each fixture with loop through.
   4. The theatrical lighting contractor shall provide DMX connectivity to each house fixture.
C. System shall work in conjunction with specified low-voltage control stations.

1. Contractor shall provide a CAT 6 control system based on a LAN control approach with DNODE and LAN patching capability. Refer to TL drawings for further details.

1.9 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.
B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.
C. The Contractor shall, without cost to the Owner/Consultant, replace any products damaged during storage, handling or during installation

1.10 SCHEDULING

A. The Contractor shall submit a schedule to the Owner/Consultant for approval within 10 (ten) working days from notice to proceed. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off. This schedule shall be submitted in Microsoft Project (or similar program) in both paper and electronic format, with submittals.
B. It is the responsibility of the Contractor to coordinate the installation of the system(s) to be compatible with the work of the other trades. The Contractor shall attend progress meetings and provide continuous on-site project management.
C. It is the responsibility of the Contractor to arrange with the Owner/Consultant a mutually acceptable time and date(s) for Acceptance Testing, based upon project dates and schedule provided, based upon the dates provided in the Solicitation.
D. The Contractor shall provide operating personnel with extensive training for each system type and/or room type as outlined in Section 1.8 SYSTEM(S) DESCRIPTION AND REQUIREMENTS.

1.11 PROJECT SCHEDULE

A. A (mandatory) pre-bid site visit on, (DATE) will be utilized to allow the Contractor to review the current jobsite conditions and define special requirements.
B. All Requests for Information (RFI) shall be directed to the Consultant and should be received by Close of Business (COB) on (DATE).
C. All bids must be received at the Warrenton office of Polysonics to the attention of the Consultant. All bid proposals (electronic copy) are due to Polysonics no later than (DATE).
D. Hard copies of the bid proposals will be provided
   1. Please submit three hard copies.
E. The opening of the bid proposals will be held between Polysonics and the Owner's Representative, with no bidder's present.

1.12 BID/TECHNICAL PROPOSALS

A. The Contractor shall be experienced in the provision of systems similar in complexity to those required for this project and Contractor shall provide documentation demonstrating the below minimum criteria:
   1. The primary business of the Contractor/Installer shall be the installation Theater Lighting systems.
   2. At least three (3) years' experience with the specified equipment and systems.
   3. Experience with at least one project of similar size and complexity as outline in these specifications.

4. Be an authorized dealer and service facility for the products specified and furnished.
5. Maintain a technically trained installation crew and service crew for maintenance and installation of the specified system(s).
6. Final Theater Lighting System(s) configurations shall be approved by the Owner's Representative, Architect and Consultant.
7. Upon request of the Owner/Consultant, Contractor shall demonstrate that he has:
    a. Sufficient facilities and equipment for this work.
    b. Sufficient staff with the appropriate technical expertise and experience for this project.
8. All Bid proposals shall be valid for ninety (90) days from date received.
9. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment.

B. Provide a list of five (5) references with locations, names of contacts, and contact phone and email information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old and be of similar size, type, and complexity as the system set forth.

C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents and drawings, manufacturer requirements, and RFI responses as applicable.

1.13 PRE-BUILD AND FINAL SUBMITTALS

A. Provide the following for approval no later than thirty (30) days after Notice to Proceed and prior to commencement of work:
1. A complete list of all products incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
3. All shop drawings defined as required.

B. Shop Drawings:
1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of system(s).
2. Shall be scaled appropriately but not less than 1/8" =1'.
3. Shall show detailed schematic wiring diagrams showing interconnection of Contractor-provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
4. Shall show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling.
5. Shall show all A.C. power outlet locations, terminal strip, and power locations within each equipment rack including all sequencing as required for proper start-up and shut down.
6. Detailed set of dimmer schedules.

7. Shall show plans and sections of the building and adjacent grounds with the location of all installed equipment such as racks, consoles, plates/panels, antennas, (etc.).
8. Shall show patch panel layouts and labeling strips, including color schemes, as necessary.
9. Shall show full fabrication detail of custom enclosures indicating dimensions, material, finish, and openings for equipment.
10. Shall provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate and sample plates per type.
11. Shall show complete labeling schemes for all cabling and equipment components for project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
12. Shall show a complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout coordination information.

C. Submittal Format: (PDF version)
1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
2. Separate major groupings Use multiple volumes / list of content
3. Index product data sheets by manufacturer and model or part number.
4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
5. Reference addendum or change order numbers as applicable.
6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
7. Provide via pdf, posted to FTP, thumb drive and or CD / DVD ROM.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

D. Submittal Format: (Printed Option)
1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
6. Reference addendum or change order numbers as applicable.
7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

1.14 PROJECT CONDITIONS

A. Verify conditions on the job site applicable to this work. Notify Owner's Representative / Consultant in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.15 QUALITY ASSURANCE

A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.

B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating Theater Lighting equipment and services. Manufacture shall be able to similar installations rendering satisfactory service.

C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.

1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.
2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.16 PRE-INSTALLATION MEETING/SCHEDULE

A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.

1.17 FINAL INSPECTION AND TESTING / COMMISSIONING

A. Upon completion of installation and Contractor testing and commissioning (as outlined in Part 3), the Consultant shall perform system(s) inspection and testing (as outlined in Part 3).

B. To assist the Consultant, the Contractor shall provide a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the specified system(s).

C. The process of testing the system(s) may necessitate moving and/or adjusting certain components such as fixture aiming, software adjustments, control system adjustments.

D. Testing will include operation of each system and all components. The Contractor will provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.
E. In the event that adjustments or work is required during testing, or to bring the systems into specification, the Contractor shall continue his work until the system(s) are acceptable with no addition to the contract price. If approval is delayed due to defective equipment, and/or failure of equipment or installation that meets the requirements of this specification, the Contractor shall pay for additional time and expenses to the Owner at the rate specified by the Owner.
F. All Control Systems shall be fully tested prior to commissioning. Once the Control Programming is finalized all source code, programming, and touch panel software shall be burned on to a CD ROM or thumb drive and delivered to the Owner. All Control System programming (including source, files, touch panel design) files shall become the property of the Owner.

1.18 WARRANTY

A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial two-year service contract.
B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.
C. The Contractor shall respond with a remedy to a trouble call within twenty-four (24) hours upon receipt of such a call and shall provide a 24-hour service phone number. Downtime for system(s) shall be no longer than a 24-hour period. All replacement parts/components shall be of equal or higher level of service.
D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.
E. At least two routine inspections and adjustment visits shall be scheduled for the first year, coordinated with Owner's Representative.
F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.
G. The Contractor shall be present at the first use of the system (scheduled by the Owner), and one (1) additional event as requested by the Owner for no additional charge.

1.19 INSTRUCTION OF OWNER PERSONNEL

A. The training time shall not be less than a total of 32 hours, and shall consist of:
    1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
    2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
    3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electronic component models shall be commercially available for at least one (1) year prior to bid or be approved by The Owner.
B. All equipment and material shall be new.
C. All equipment must be UL listed or built to UL standards, where required.

2.2 GENERAL

A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied, unless a variance (separate document) is submitted and approved by the Owner.
B. System shall be installed and configured for simplicity of operation, with user-friendly controls.
C. Product quantity is as required for a complete and operable system. If any quantities are given, Theater Lighting Contractor shall provide at least the given amount. Some of the product listed under this section may not be required to fulfill the work as outlined.
D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacture's specifications.

2.3 DISTRIBUTION SYSTEM

A. Lighting Dimmer Rack (LDR 1):
   1. 24 Dual circuit dimmable rack unit
   2. Dual 20amp Dimmable Module
   3. Dual 20amp ThruPrower Module
   4. On-board control intelligence
   5. Acceptable Product:
      a. ETC SR24
      b. ECT CEM3
      c. ETC D20E
      d. ETC TR20AF
B. Intelligent Breaker System (LDR 2)
   1. 24-position breaker subpanel
   2. Mains Feed: Three-phase 120/208V four-wire plus ground
   3. DMX-512 input or stand-alone control
   4. Built-in control includes: sequencer; presets, local overrides, time and astronomical events
   5. Acceptable Product
      a. ETC Sensor IQ 24 rack
C. Power distribution:
   1. Supplied as part of theater lighting system
   2. Integrated circuit numbering
   3. Supplied from Theater lighting manufacture
   4. Supply connections between Gridiron JBs to strips with S/O cable
   5. All S/O cable shall be supplied with and installed with hangers and strain reliefs.
   6. Provide all strips with necessary connectors and hangers
   7. See drawings for power distribution details.
   8. Acceptable Product:

a. ETC Wall Boxes
b. ETC Connector strips

2.4 CONTROL SYSTEM

A. Console:
1. Console shall be DMX and Net3 compatible
2. Control and programming capable
3. Provide with additional Fader Wing
4. Provide with touch screen monitors
5. Acceptable Product
a. ETC ION
b. ETC Fader Wing
c. Touch Screen monitor (Qty:2)

B. Hub/Switch:
1. 24 port LAN switch
2. CAT 5e capable
3. Rack mountable
4. Acceptable Product:
a. NetGear or equal

C. Control Interface Wall Plate (CS1):
1. 5 Button wall station
2. Single gang
3. Supply with wall box
4. Acceptable Product
a. ETC UH10005 (color to be determined by Arch)

D. Control Interface Wall Plate (CS2):
1. 5 Button wall station
2. 1 Fader
3. Single gang
4. Supply with wall box
5. Acceptable Product:
a. ETC UH10105_1F (color to be determined by Arch)

E. DNODE Interface:
1. Supports ETCNet2
2. DMX I/O
3. POE
4. Single Gang
5. Supply with wall box
6. Acceptable Product:
a. Net3 One-Port Gateway

F. Electronics Module:
1. Acceptable Product:
a. ETC CEM+
b. ETC P-ACP

G. Power Unit:
1. Power supply for LAN based systems
2. Power over Ethernet
3. Fully IEEE 802.3af

4. Rack mountable
5. Acceptable Product:
    a. PowerDsine 6006 w/ power supply and rack ears

H. Lighting Control Equipment Rack (LCR):
1. Acceptable Product:
    a. Mid Atlantic DWR

I. Emergency Lighting Transfer Switch:
1. NEMA Enclosure
2. Continuous Monitoring of normal and emergency power
3. UL listed
4. Satisfies NFPA 70
5. Up to 12 20A emergency circuits
6. Fire alarm input
7. Acceptable Product:
    a. ETC ELTS2-1-M-3P-12

J. Airflow Option Module:
1. Acceptable Product:
    a. ETC AIR

K. Control Cable:
1. Acceptable Product:
    a. ETC CD-12-NET

L. Ethernet Node:
1. Acceptable Product:
    a. ETC N31G

M. Net to DMX Node:
1. Provide with C-clamps for mount
2. Acceptable Product:
    a. ETC N31G

N. GIJB:
1. Acceptable Product:
    a. ETC 9730

O. 50' Stage-Pin Distribution cable:
1. Acceptable Product:
    a. EPS - CSSP12/3050M

P. 25' Stage-Pin Distribution cable:
1. Acceptable Product:
    a. EPS - CSSP12/3025M

Q. 10' Stage-Pin Distribution cable:
1. Acceptable Product
    a. EPS - CSSP12/3010M

R. 5' Stage-Pin Distribution cable:
1. Acceptable Product:
    a. EPS - CSSP12/3005M

S. 20amp Stage-Pin 2-fers:
1. Provide a minimum of twelve
2. Acceptable Product:
    a. EPS-TFSPMLD1.5M

2.5 FIXTURES

B. Fixtures:
1. Provide DMX Control Cables for all LED Fixtures
2. ETC Color Source PAR (Qty:20)
3. ETC Color Source Spot with CYC lens tube (Qty:4)
4. ETC Color Source Spot with 19 degree Enhanced Def lens tube (Qty:10)
5. ETC Color Source Spot with 26 degree Enhanced Def lens tube (Qty:10)
6. Strand 8" Fresnel (Qty:15)
7. ETC Source four 14degree (Qty:8)
8. ETC Source four 19degree (Qty:8)
9. ETC Source four 26degree (Qty:12)

C. Safety Chain:
1. Provided as needed.
2. Acceptable Product:

a. ETC 400SC

D. Spot Light (Optional):

E. Acceptable Product:
1. Canto USA Canto 700 (Optional)

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Contractor to receive and store the necessary materials and equipment for installation of the dimmer system. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The Contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The Contractor shall install all lighting control and dimming equipment in accordance with manufacturer's approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

3.2 LABELING

B. Device Labeling:
1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

C. Rack Labeling:
1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
2. All rack panel labeling shall be engraved and filled.

D. Wire and terminal strip labeling:

1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
4. Wiring designator shall be alphanumeric code, unique for each cable.
5. Each cable type shall be labeled starting with different destinations (i.e. Control cabling "Cxxx", Network cabling "Nxxx", etc.).
6. On projects that have multi room connectivity the source and destination room numbers should be the prefix for the cable number indicting a cable that traverses between two rooms.
7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.3 OUTDOOR EQUIPMENT MOUNTING

A. Outdoor Mounting Requirements:
1. All outdoor mounting hardware shall be non-corrosive.
2. Any exposed structural supports for lighting fixtures or other outdoor components shall be non-corrosive or covered with an inhibiting layer.
3. Any components mounted outside shall be secured in such a way as to prevent movement caused by wind or storms.
4. Provide screened covering over all openings in horn type enclosures to keep out birds, insects, or small animals.

3.4 CONTRACTOR TESTING AND OR COMISSIONING

A. Prior to energizing or testing the system(s), ensure the following:
1. All products are installed in a proper and safe manner per the manufacturers' instructions.
2. Insulation and shrink tubing are present where required.
3. Dust, debris, solder, splatter, etc. is removed.
4. Cable is dressed, routed, and labels and all connections are consistent.
5. All labeling has been provided and installed.
6. All products are neat, clean, unmarred and securely fastened.
7. All debris has been cleaned and removed from the site.
8. All electronic devices are properly grounded.

B. Before Acceptance Tests are scheduled, the Contractor shall perform their own system check-out. He shall furnish all required test equipment and shall perform all work necessary to determine and / or modify performance of the system to meet the requirements of this specification.

C. Testing items:
1. Testing of theater lighting systems shall include but, not be limited to, the following items as applicable to the systems installed:
a. Provide documentation that all lighting circuits dimmable and non-dimmed have been tested and verified and are functioning properly.
b. Provide documentation that all control signal connections have been tested and verified.
c. Provide documentation that all mounting and rigging elements have been verified for structural integrity and safety.

d. Provide documentation that all fixtures and lamps have been verified and are functioning properly.

3.5 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.
B. Notification shall be provided in writing, two weeks prior to the time factory-trained personnel are needed on the job site.
C. No power is to be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.
D. The contractor shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

3.6 SPARE PARTS

A. Provide replacement fuses, lamps, batteries and connectors in sufficient quantities to last one (1) year.

3.7 CONSULTANT ACCEPTANCE TESTS

A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined above has been completed and the test results have been received and reviewed by the consultant and or owner.
B. Consultant acceptance testing will be conducted based on the above outlined information and in accordance with the necessary test to show a fully complete, functional, and operating system(s)
C. Checklist items within this list will be verified by visual and or audible methods as part of normal room use case operational scenarios, with the assumption that the Contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per manufacture requirements and the above.
D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
    1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
    2. The operation of all system equipment shall be demonstrated by the contractor.
    3. Contractor shall provide a laptop to support testing activities that is configured and ready connect to any and all control equipment for any adjustments that may be required by the consultant.
    4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection / configuration.
    5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
    6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
    7. In the event further adjustment is required, or defective equipment must be repaired or re-placed, tests may be suspended or continued at the option of the consultant.

E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's/Project's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide all materials and labor for the installation of a permanent Grounding and Bonding System for Telecommunications Infrastructure, including Pathways, Spaces, Equipment, Raceways, Enclosures, and Communications Circuits within the project areas of the building as per this document and the accompanying Drawings.
   2. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections.

B. Additional contractor requirements:
   1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
   2. Verification of dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the authority having jurisdiction.
   4. Submittal information and provisions.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including Divisions 0, 1, 15, 26, 27, 28, and the general contract specifications as applicable.

B. Related specification sections:
   1. Section 270528 Pathways for Communications Systems
   2. Section 270529 Hangers and Supports for Communications Systems
   3. Section 270536 Cable Trays for Communications Systems
   4. Section 271100 Communications Equipment Room Fittings
   5. Section 271116 Communications Racks, Frames and Enclosures
   6. Section 271313 Communications Copper Backbone Cabling

1.4 RELATED WORK

A. The Contractor shall coordinate with the Electrical Contractor and all other trades as needed on cable raceway and penetration locations for routing of cables required for the grounding and bonding system.

B. Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are not limited to:
   1. Section 078413 – Penetration Firestopping
   2. Section 260526 – Grounding and Bonding for Electrical Systems
   3. Section 260529 – Hangers and Supports for Electrical Systems

4. Section 260533 – Raceway and Boxes for Electrical Systems

1.5 DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words or phrases, as used in the Drawings and/or the Specifications, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. Contractor – Integrator or Installer who has been awarded the contract to perform the work under this section.
   2. Shall is mandatory instruction
   3. Will is informative.
   4. Should is advisory.
   5. Provide – To supply, install, connect, and configure, for safe intended normal operation.
   6. Indicated, Shown, or Noted – As indicated on drawings or specifications.
   7. Equivalent, Similar, or Equal – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
   8. Reviewed, Satisfactory, Accepted, Approved, and Directed – As reviewed and considered satisfactory, acceptable, approved, or directed by the Owner or Owner's Representative.
   9. EMT – Electrical Metallic Tubing.
   10. SMR – Surface Metal Raceway.
   11. Raceway – any enclosed channel for routing wire, cable or TBB(s).
   12. TMGB – Telecommunications Main Grounding Busbar. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
   13. TGB – Telecommunications Grounding Busbar. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to the buildings structural steel or other permanent grounded metallic systems.
   14. TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect TMGBs to TGBs.
   15. Pull Box – a metallic box with a detachable cover, used to enable pulling cable through conduit runs longer than 100' or where there are more than 180 degrees of bends.
   16. Junction Box – a pull box where a feeder conduit transitions to multiple distribution conduits.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Systems shall be installed in accordance with the latest revisions of all applicable national, state, and local codes and standards including, but not limited to the following:
      a. Federal, State and Municipal Building Codes and the codes and standards of all other Authorities Having Jurisdiction
      b. ASTM International (ASTM)
      c. ASTM B3 Standard Specification for Soft or Annealed Copper Wire
      d. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
      e. ASTM B33 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
      f. ASTM E814 Standard Test Method for Fire Tests of Firestop Systems
      g. International Code Council (ICC)
      h. International Building Code (IBC) / BOCA National Building Code
      i. Occupational Safety and Health Administration (OSHA)

j. Occupational Health and Safety Standards (Standards – 29 CFR)

2. Institute of Electrical and Electronic Engineers (IEEE)
   a. IEEE C2 National Electric Safety Code (NESC)
   b. IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
   c. IEEE 837 Standard for Qualifying Permanent Connections Used in Substation Grounding
3. National Fire Protection Agency (NFPA):
   a. NFPA-70 National Electric Code (NEC)
   b. NFPA-70B Recommended Practice for Electrical Equipment Maintenance
   c. NFPA-72 National Fire Alarm and Signaling Code
   d. NFPA 780 Standard for the Installation of Lightning Protection Systems
4. National Electrical Manufacturers Association (NEMA)
   a. NEMA 250 Enclosures for Electrical Equipment (100 Volts Maximum)
5. Telecommunications Industry Association (TIA):
   a. TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
   b. TIA-568.0-D-1 Commercial Building Telecommunications Infrastructure Standard
   c. TIA-569-D Telecommunications Spaces and Pathways
   d. TIA-606-C Administration Standard for Telecommunications Infrastructure
   e. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
   f. TIA-862-B Structured Cabling Infrastructure Standard for Intelligent Building Systems
   g. TIA 942-A Telecommunication Infrastructure Standard for Data Centers
   h. TIA 1005-A Telecommunications Infrastructure Standard for Industrial Premises
6. BICSI:
   a. Telecommunications Distribution Methods Manual (TDMM), 13th Edition
   b. Information Technology Systems Installation Methods Manual, 6th Edition
7. Underwriters Laboratory
   a. UL 1 Standard for Flexible Metal Conduit
   b. UL 5 Standard for Surface Metal Raceways and Fittings
   c. UL 50 Standard for Enclosures for Electrical Equipment
   d. UL 96 Standard for Lightning Protection Components
   e. UL 360 Standard for Liquid-Tight Flexible Metal Conduit
   f. UL 467 Grounding and Bonding Equipment
   g. UL 486A, 486B Wire Connectors
   h. UL 514A Metallic Outlet Boxes
   i. UL 514B Conduit, Tubing, and Cable Fittings
   j. UL 797 Electrical Metallic Tubing – Steel
   k. UL 1479 Standard for Fire Tests of Penetration Firestops

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

A. System Summary: The Telecommunications Grounding and Bonding System shall be designed and installed in accordance with TIA-607-C and BICSI best practices.

B. The following is for a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The Specifications and the Contract Drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.

C. The Contractor shall provide Grounding and Bonding infrastructure that shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements as applicable.

D. Materials:
   1. Furnish and install at locations that show the specified equipment to provide a completely operational Telecommunications Grounding and Bonding System without additional cost to the Owner.
   2. The following list of main items of the installation shall not be considered to be all-inclusive:
      a. Telecommunications Ground Bar(s)
      b. Telecommunications Bonding Backbone Cabling
      c. Exothermic Welds
      d. Listed Lugs, Pressure Connectors, and Clamps
      e. Ground Electrodes
      f. Supports, Straps, and Installation Accessories.

1.8 RELATED WORK

A. Conduits:
   1. It is the Contractor's responsibility to review all existing designed Telecommunications Spaces and Pathways to ensure complete integration of the Grounding and Bonding System.
   2. It is the Contractor's responsibility to review and ensure compatibility and safe, proper integration with the Building AC Electrical Grounding system and the Building Lightning Protection System.

1.9 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.

B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.10 PROJECT SCHEDULE

A. Project schedule shall follow the division 0 (or equivalent) construction schedule

1.11 BID/TECHNICAL PROPOSALS

A. Bid proposal shall follow division 0 (or equivalent), and the general contractor requirements for bidding.

1.12 SUBMITTALS

A. In addition to the following, Submittals requirements shall follow Division 0, and the General Contractor requirements for submittals.

B. Action Submittals:
   1. Product Data: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.

2. For those items noted as "Or Equal" and which are not being provided as specifically named, submit standard cut sheets or other descriptive information, along with a separate written description detailing the reason(s) for the substitution.
    a. Provide standard manufacturer's cut sheets at the time of submittal review for each indicated product in the system. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive said materials.
3. Shop Drawings: Submit shop drawings for approval prior to fabrication or installation. Include detailed plans, required clearances, installation methods, and accessories. Include any relationships with adjacent equipment and materials.

C. Closeout Submittals
1. As-Built Drawings: At the completion of the project, the contractor shall submit complete records to the Owner/Project Manager, reflecting any changes that occurred during the process of construction.
    a. Records shall be maintained at the project site and shall consist of:
        1) A minimum of one set of As-Built Drawings with redline markups reflecting any changes or deviation from the system as initially shown on Contract Documents, and clearly identified component labels and identifiers,
        2) A minimum of one full set of Specifications with all Addenda.
        3) Any and all related spreadsheets or documentation.
    b. Keep Records at the job site and make available to Owner and or Designer at all times.
    c. Keep Records current throughout the progress of construction. ("Current" is defined as not more than one (1) week behind actual construction).
    d. Show identifiers for major infrastructure components on Drawings.
2. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
    a. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.
    b. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
    c. Include recommended testing intervals.

1.13 PROJECT CONDITIONS

A. Verify conditions on the jobsite applicable to this work. Notify General Contractor and or Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

1.14 QUALITY ASSURANCE

A. In addition to the following, Quality Assurance requirements shall follow division 0, and the general contractor requirements for quality assurance.

B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. Comply with NFPA 70, "National Electrical Code".
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Article 100 of NFPA 70, by an acceptable testing agency, and marked for intended use.

2. Comply with UL 467.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

E. Comply with ANSI TIA 607-C

1.15 PRE-INSTALLATION MEETING/SCHEDULE

A. If applicable, Pre-installation meeting and schedule shall follow division 0 and the general contractor requirements for meeting attendance.

1.16 FINAL INSPECTION AND TESTING / COMMISSIONING

A. Inspection and testing requirements shall follow division 0, and the general contractor requirements for inspection.

1.17 WARRANTY

A. Warranty requirements shall follow division 0, and the general contractor requirements for warranties for materials and labor.

B. Unless otherwise specified, provide a Contractor-endorsed warranty against defects in materials and workmanship.
   1. Provide one year on site labor warranty.
   2. Provide 20-year material warranty
   3. The Contractor Warranty period shall initiate upon equipment installation at the site

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All material shall be new unless otherwise noted in this specification.

B. All materials must be UL listed or built to UL standards, where required.

2.2 GENERAL

A. The sizes and quantities of all conductors, accessories, and materials shall be determined and installed by the Contractor based on the requirement to provide a complete grounding and bonding solution.

B. For insulated conductors, comply with Division 26 Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. All Telecommunications Grounding and Bonding Materials shall be copper, unless otherwise specified.

D. Equipment Grounding Conductors shall be insulated with green-colored insulation.

E. 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.

F. Grounding Electrode Conductors: Stranded copper cable.

2.3 PRODUCTS

A. Bare Copper Conductors: Comply with the following:
   1. Solid Conductors: ASTM B 3.
   2. Assembly of Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

B. Copper Bonding Conductors for Communications: As follows:

1. From TMGB to service equipment ground (power): minimum 3/0 AWG insulated copper conductor.
2. Telecommunications Bonding Backbone (between new TGB(s) and existing building TGB(s)): minimum 3/0 AWG insulated copper conductor.
3. Bonding Conductor (between TGB(s) and electrical ground: minimum 3/0 AWG insulated copper conductor.
4. Overhead Bonding Conductor (MDF): minimum 2 AWG insulated copper conductor.
5. Equipment Bonding Conductors: minimum 6 AWG insulated copper conductor.

C. Grounding Bus Bars
1. Shall be bare, annealed copper bars of rectangular cross section, with insulators as shown on drawings.
a. Telecommunications Main Grounding Bus bar (TMGB) in MDF:
1) (20" x 4" x ¼"), Pre-drilled: CPI 40153-020
2) Or approved equal
b. Telecommunications Grounding Bus bar (TGB) in IDFs:
1) (12" x 4" x ¼"), Pre-drilled: CPI 40153-012
2) Or approved equal

D. Grounding Lug
1. Exothermically welded lug attaching directly to building steel

E. Connector Products
1. Comply with IEEE 837 and UL 467.
2. Listed for use for specific types, sizes, and combinations of conductors and connected items.

F. Bolted Connectors:
1. UL Listed
2. Tin-plated copper connector.
3. Two-hole, long barrel compression type with window lug.
4. Code or Flex, as required.

G. HTAP Connector
1. UL Listed
2. Tin-plated copper connector.
3. For use with parallel or multiple tap connections.
4. Compression type with separated tap grooves for independent use.
5. Code or Flex, as required.
6. Include clear cover.

H. Welded Connectors:
1. Exothermic-welded types, in kit form, and selected per manufacturer's written instructions
a. CAD Weld
b. Or approved equal

I. Firestopping Material:
1. Must conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted testing agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of actual field conditions.
2. Firestopping material that is used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
3. Fire stopping material may be a re-entry mechanical system
4. Acceptable Manufacturers:
a. Hilti

b. 3M
c. EZ Path
d. Or approved equal

J. Labels:
1. As recommended in TIA-606-C.
2. Permanently fastened.
3. Factory printed or created by hand-carried label maker or a software-based label making system.
4. Handwritten labels are not acceptable.
5. Acceptable materials:
a. Panduit Telecommunications Grounding and Bonding Conductor Label Kit
b. Brady ID Pro Plus with Wire Marking Labels WML-511-292
c. Or approved equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in Section 1.6 of this document, above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Install grounding and bonding system in a manner ensuring that telecommunications circuits, equipment, enclosures, raceways, and components, when installed, are able to fully comply with the NEC, TIA, BICSI and other references listed in these specifications.

F. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

G. Remove surplus material and debris from the job site and dispose of legally.

3.2 EXAMINATION

A. Examine surfaces and for compliance with installation tolerances and other conditions affecting performance of grounding and bonding component installation. Do not proceed with installation until insufficient conditions have been amended.

3.3 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors.

B. In raceways, use insulated equipment-grounding conductors.

C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

D. Grounding Bus for Communications: Install in Telecommunications Entrance Facilities, Telecommunications Equipment Rooms, Telecommunications Rooms, Telecommunications Spaces, and elsewhere as indicated.
   1. Use insulated spacer; space 2 inches from wall and support from wall 96 inches above finished floor, unless otherwise indicated.
   2. TBB: Provide TBB(s) as applicable on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment to the nearest TGB if the direct bonding method is not employed. Use TBB(s) to connect the TMGB to each of the TGB(s) if the legacy telecom (TBB) bonding method is employed. The Contractor shall route along the shortest and straightest path possible with minimum bends. All bends shall be sweeping. TBB(s) shall be continuous (without splices).
   3. Install the TBB without splices where practical. When splices are necessary they shall be minimal in quantity, accessible, and located in telecommunications spaces.
   4. The bonding conductor for communications shall bond components, equipment and cable sheaths.
   5. TMGB: Provide a minimum of one TMGB per Telecommunications Entrance Facility (EF) for each building. Install TMGB(s) and directly bond TMGB(s) to the verified electrical service ground and to the related TBB(s) if a legacy TBB is employed.
   6. Install the TMGB in the Telecommunications Entrance Facility (EF) such that it is accessible to telecommunications and building facilities personnel
   7. TGB: Provide a minimum of one TGB per Telecommunications Room (TR), as shown on the Contract Documents, and as required by standards, references and codes listed above in Section 1.6 of this document. Directly bond each TGB to a dedicated structural steel ground lug within the space and/or to its related TBB.
   8. The TBB and other telecommunications grounding bus bars within the same space shall be bonded to the TGB with a grounding conductor that is not less than 2/0 AWG. It shall be an insulated copper conductor. Routing shall be continuous, short, and as straight as possible.
   9. Do not use interior water piping system, metallic cable shield, metallic conduit, trunking, cable tray, or cable ladder as a TBB.
   10. The TBB is a dedicated conductor.

3.4 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Comply with TIA 607-C.

C. For alarm, voice, data, and other communication systems, provide insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, telecommunications rooms, and central equipment location.
   1. Terminate grounding conductor on a minimum 1/4" x 4" x 12" grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding bus bar/terminal.

D. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

C. When bonding to painted surfaces, remove paint at contact location and use antioxidant paste, or use paint-piercing bonding washers and antioxidant paste.

D. Metal Water Service Pipe: Do not connect to communications ground system.

E. Water Meter Piping: Do not connect to communications ground system.

3.6 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturers written instructions. Welds that are puffed up or that show convex surface indicating improper cleaning are not acceptable. Refer to Division 26 Section 260526 "Grounding and Bonding for Electrical Systems" for acceptable locations for exothermic-welded connections.

C. Equipment Grounding Conductor Terminations: For 6 AWG and larger, use pressure-type grounding lugs. 6 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Screws and Bolts for Grounding and Bonding Connectors and Terminals: Tighten according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor. Use only two-hole lugs for connections to TGB and TMGB. Refer to Division 26 Section 260526 "Grounding and Bonding for Electrical Systems" for acceptable locations for compression-type connections.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.7 FIRESTOPPING:

A. The Telecommunications Contractor shall maintain the fire rating of all penetrated fire barriers. Firestop and seal all penetrations made during the SCS installation.
   1. Provide fire stopping material for through and membrane penetrations of fire-rated barriers.
   2. Install firestops in strict accordance with manufacturer's detailed installation procedure.
   3. Install firestops in accordance with fire resistance requirements, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1-1.6 REFERENCES. Apply sealing material in a manner acceptable to the local fire and Authority Having Jurisdiction, AHJ.

3.8 LABELING:

A. Label Telecommunications Grounding and Bonding Components in accordance with TIA-606-C:
   1. Label TMGB(s) with "TMGB", [number] per TIA-606-C.
   2. Label TGB(s) with "TGB", [number] per TIA-606-C.
   3. Label TBB(s) with "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 FIELD QUALITY CONTROL

A. Testing:
   1. Perform the following field quality-control testing:
      a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
      b. Perform visual inspection of all existing and installed bonding components.
      c. Perform voltage test to ensure the absence of ground faults travelling through Telecommunications Bonding System.
      d. Prior to installation of any Telecommunications equipment, perform two-point ground testing:
         1) Between TMGB (MDF) and nearest electrical grounding electrode.
         2) Between TMGB (MDF) and existing building TMGB.
         3) Between TGB (IDFs) and nearest electrical grounding electrode.
         4) Between TGB (IDFs) and nearest existing building TGB.
         5) Between other points in the Telecommunications Bonding System, as necessary.
      e. The maximum value for resistance between any of the points listed above shall be 100 milliohms.

3.10 CONSULTANT ACCEPTANCE TESTS

A. Owner's Representative and or consultant shall approve grounding and bonding testing/inspection reports.

B. Final Owner's Representative and/or consultant acceptance will be performed along with the acceptance of completed telecommunications systems.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. This Section specifies the requirements for the Pathways for Communications Systems for the Glenridge Middle School Project.

B. The Owner's/Project's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Provide all materials and labor for the installation of a permanent Communications Pathway System as hereinafter identified and/or reflected per this document and the accompanying drawings.

B. Communication Pathways are defined to include, but are not limited to, horizontal and building backbone raceways, fittings and boxes, conduit, pull boxes, sleeves, cable trays, ladder rack, supports, accessories, associated hardware and fire stopping materials specific to cabling for voice and data.

C. The primary horizontal cable support system will be cable tray, installed as shown in the TN drawings. Cable tray will be properly grounded. Wall penetrations shall transition to properly fire-stopped 1"- 4" sleeves, then back to cable tray.

D. Work furnished and installed by Electrical Contractor as specified in this Section and as shown in the TN drawings includes:
   1. Equipment/Telecommunications Rooms- cable tray and ladder rack installation.
   2. Overhead- Backbone and Horizontal Communication Pathways.
   3. Work Area Outlets- conduits and back boxes.
      a. Outlets having one single cable require a single gang box that stubs up into the ceiling void via one (1) 1" conduit with pull string.
      b. Outlets having two or more cables require a double gang box with a single gang reducer that stubs up into the ceiling void via one (1) 1" conduit with pull string.
      c. Conduit runs may not be longer than 100ft or have more than two 90-degree bends without the use of a properly sized junction box.
      d. Insulated throat compression fittings must be used for communications conduit runs, with termination points having plastic or grounding bushings installed.
      e. Minimum radii for conduit bends shall be as follows:
         1) Internal diameter of less than two (2) inches is 6 times the internal diameter.
         2) Internal diameter of more than two (2) inches is 10 times the internal diameter.
   4. The floor poke through hardware.
   5. Fire stopping of cable tray and conduit cable pathways.
   6. Bonding and grounding of overhead cable pathway system- cable tray/ladder rack, racks and cabinets within the ER/TRs.

E. Completely coordinate with work of other trades.

1.3 SECTION INCLUDES

A. Interior communications pathways and supports.

B. Outlets and conduit runs.

C. Risers in ER/TR(s).

D. Grounding and bonding of pathways.

E. Pathway fire stopping requirements.

1.4 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Division 27 Sections include:
   1. 270529 Hangers and Supports for Communications Systems
   2. 270536 Cable Trays for Communications Systems

1.5 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. The pertinent portions of the following specifications, standards, regulations and codes shall be incorporated by reference into these specifications.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Occupational Safety and Health Act (OSHA)
      d. NEMA VE 1 – Metallic Cable Tray Systems
      e. NEMA VE 2 – Cable Tray Installation Guidelines
   2. Communications:
      a. TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
      b. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard.
      c. TIA-569-D Telecommunication Spaces and Pathways.
      d. TIA-606-C Administration Standard for Telecommunications Infrastructure.
      e. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
      f. BICSI TCIM BICSI Telecommunications Cabling Installation Manual.
      g. BICSI TDMM BICSI Telecommunications Distribution Methods Manual.

1.6 DEFINITIONS

A. "EMT" shall mean Electrical Metallic Tubing.

B. "Raceway" shall mean any enclosed channel for routing wire, cable or busbars.

C. "TMGB" shall mean Telecommunications Main Grounding Busbar. There is typically one (1) TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

D. "TGB" shall mean Telecommunications Grounding Busbar. There is typically one (1) TGB per Telecommunications Room (TR). The TGB is connected both to the TMGB and to the building structural steel or other permanent metallic systems.

E. "TBB" shall mean Telecommunications Bonding Backbone. The TBB is a conductor used to connect TMGBs to TGBs.

F. "Pullbox" shall mean a metallic box with a removable cover, used to assist pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends. Pullboxes shall have no more than one (1) conduit entering and one (1) conduit exiting the box.

G. "Junction Box" shall mean a pullbox wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

A. Furnish, install, and place into adequate and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Communications Pathways System for Telecommunications Circuits as specified in the Contract Documents. The Communications Pathways System shall support an ANSI/TIA/EIA and ISO/IEC compliant telecommunications Structured Cabling System (SCS).

1.8 SUBMITTALS INFORMATION

A. Product Data Submittals: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.

B. Closeout Submittals:

1. Records- Maintain at the project site a minimum of one set of Drawings, Specifications, and Addenda. Drawings shall consist of redline markups, specifications and spreadsheets.
   a. Document changes to the system from that initially shown from the Contract Documents, and clearly identify component labels and identifiers on Drawings.
   b. Keep Drawings current throughout the progress of construction. ("Current" is defined as not more than one (1) week behind actual construction).

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required for a complete, permanent Communications Pathway System. Provide all incidental and or miscellaneous hardware not explicitly shown in the Contract Documents but that is required for an operational system.

B. Physically verify existing site conditions prior to purchase and delivery of materials.

C. Communications Pathways System components must be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.

2.2 MATERIALS AND FINISH

A. Cable Tray (Welded Wire): Cable Tray shall be constructed of a welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete with all tray supports, materials, and supplementary and miscellaneous hardware required for a complete cable tray system.

1. Finish: Carbon steel with electro-plated zinc galvanized finish.
2. Width: Width shall be as shown on the Contract Documents. Where cable tray width is not shown in the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown in the Contract Documents) plus an additional 100% for future expansion.
3. Depth: Minimum of two (2) inches.

4. Mesh: 2 x 4 inches.
5. Fittings: Fittings shall be field fabricated from straight sections using manufacturer-approved tools and in accordance with the manufacturer's instructions.
6. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, cable tray shall be complete with bolted splicing hardware for grounding/bonding throughout the entire cable tray system.

B. Ladder Rack: (Telco Style) Ladder rack shall be manufactured from tubular steel. Stringers (sides) will be made from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness. Cross members (rungs) will be made from 1" wide by ½" high tubular steel with .065" wall thickness.
   1. Ladder rack (stringers) will be 9'-8½ "long. Cross members will be welded in between stringers on 9" centers beginning 4-1/4" from one end so that there are thirteen cross members per ladder rack. There will be 8" of open space in between each cross member.
   2. Ladder rack will be UL Classified for suitability as an equipment-grounding conductor only. Minimum combined cross-sectional area of the stringers will be 0.40 square inches. A label affixed to the side stringer of the ladder rack will identify the manufacturer, the UL Classification and the minimum combined cross-sectional area of the stringers.
   3. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, ladder rack shall be complete with bolted splicing hardware for grounding/bonding throughout the entire system.

C. Conduit and Fittings: For each communication outlet indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.

D. Wall and Ceiling Outlet Boxes: All wall outlets shall be mounted in a minimum four (4)-inch by four (4)-inch by two and one eight (2 1/8) inch deep double gang outlet box with a single gang mud ring and furnished with a pull string. Outlet box accessories as require for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

E. Pull/Junction Boxes: Pull boxes used with telecommunications conduits in interior locations shall be rated NEMA-1. Pull boxes used in damp or wet locations such as plumbing chases or out of doors shall be rated NEMA-3R. Pull boxes shall be installed in conduit runs at an interval of no greater than every 100 feet. A pull box shall be installed in conduit runs whenever there are two 90-degree sweeps or a total of 180-degree sweeps in a conduit run. A pull box may not be used to change the direct ion of a conduit run.

2.3 FIRESTOPPING MATERIALS

A. Firestopping Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL1479 fire test in a configuration that is representative of the actual field conditions.

2.4 LABELING AND ADMINISTRATION

A. Labels: As recommended in TIA-606-C. Permanent (i.e. not subject to fading or erasure), permanently affixed and created by hand carried label maker or a computer/software-based label making system. Handwritten labels will not be acceptable.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and or regulations are more stringent, in which case the local codes and or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in Article 1.5 REFERENCES, above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to Owner.

F. Install the communications pathways system in a manner ensuring that telecommunications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Article 1.5 REFERENCES, above.

G. Remove all surplus material and debris from job site and dispose of them legally.

3.2 INSTALLATION

A. Provide cable trays above suspended ceilings in corridors and as shown on the Contract Documents and in the MDF and IDF rooms for backbone cabling and horizontal distribution.

B. Cable trays shall be hung trapeze style. Center hung tray is unacceptable. The inside of the cable tray or wire way shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) shall have the portion within the tray protected with a smooth, non-scratching covering so that cable can be pulled without physical damage. When a wire way passes through a partition or wall, it shall be an unbroken length. Installation of telecommunications cables shall not exceed the fill requirements. Openings in fire-rated walls, floors and ceilings shall be properly fire stopped. Barriers between power and telecommunications cables shall be installed per electrical code. Cable trays and wire ways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.

C. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the applicable class as specified in the electrical code. A support should be placed within 600 mm (2 ft.) on each side of any connection to a fitting. Wire ways shall be supported on 1500 mm (5 ft.) centers unless designed for greater lengths.

D. Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.

1. Cable tray shall be installed plumb, level and square with finished building surfaces.

2. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
3. Cable tray elevation changes shall be gradual.

E. Cable Tray Routing:
1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous or corrosive areas.

F. Cable Tray Clearance Requirements:
1. Clearance requirements for cable tray accessibility:
   a. Maintain a clearance of 6" between top of cable tray and ceiling structure or other equipment or raceway.
   b. Maintain a clearance of 8" between at least one side of cable tray and nearby objects.
   c. Maintain a clearance of 6" between bottom of cable tray and ceiling grid or other equipment or raceway.
2. Clearance requirements from sources of electromagnetic interference (EMI):
   a. Maintain a clearance of 6" or more from fluorescent lighting.
   b. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
   c. Maintain a clearance of 48" or more from motors or transformers.
   d. Pathways shall cross perpendicularly to electrical power cables or conduits.
3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot- water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit.

G. Cable Tray Fittings:
1. Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer's instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically called out on the Contract Documents.

H. Cable tray supports shall be provided according to the manufacturer's recommendations.
1. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
2. Where cable trays abut walls, provide wall-mounted supports.
3. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
4. Trays shall be supported at 5-foot intervals minimum, or more frequently if required by the manufacturer.

I. Load Span Criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.

J. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation.

K. Wire-type cable tray shall be cut with a manufacturer-approved cutter with "offset cutting blade" jaws and a minimum 24-inch handle.

1. The choice and position of the jaws at the point where the cut is made shall allow shearing as close as possible to the intersection of the steel wires.
2. Cuts shall ensure the integrity of the galvanic protective layer.

L. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where cable tray crosses building expansion joints in addition to where shown on the Contract Documents. Provide bonding jumper except where expansion joints are explicitly approved for bonding.

M. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and also during normal occupancy and operation.

N. Barrier Strips: Provide barrier strips as recommended by manufacturer.

O. Radius Drops: Provide cable tray radius drops where cable trays cross other telecommunications cable trays or ladder rack in addition to where shown on the Contract Documents.

P. Slots/Sleeves: Provide slots/sleeves where required and where shown on the Contract Documents. Provide hammer drilling, core drilling and saw cutting where required for installation. Seal and firestop (firestop only if fire rated barrier) between slot/sleeve and cable tray.

3.3 GROUNDING AND BONDING

A. Grounding/Bonding: Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in Article 1.5 REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.

B. Bond metallic raceway (including cable tray) together and to the nearest TGB (as provided under Division 27 Section 270526 — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

C. Cable Tray Bonding Splices: Provide cable tray splices according to manufacturer requirements to create a continuous bonding conductor throughout the entire cable tray.

D. Bonding Conductors:
1. Bond distribution conduits to cable tray.
2. Provide bonding jumpers at expansion joints, sleeves and any other locations where electrical continuity is interrupted.
3. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

3.4 FIRESTOPPING

A. Only employees trained/certified by the fire-stopping manufacturer shall apply fire-stopping materials.

B. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
1. Provide fire stopping material for through and membrane penetrations of fire-rated barriers.
2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in Article 1.5 REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.

4. For demolition work, apply fire stopping to open penetrations in fire rated barriers where cable is removed. Apply fire stopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

3.5 CLEANING AND PROTECTION

A. After completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

3.7 LABELING AND ADMINISTRATION

A. Provide the following two labels, alternating one label every 10 feet, along the entire length of the cable tray:
   1. Label #1: Label shall read "TELECOMMUNICATIONS/LOW VOLTAGE CABLING ONLY".
   2. Label #2: Label shall read "WARNING! CABLE TRAY SERVES AS A TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT DISCONNECT!"

END OF SECTION

SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of hangers and supports for communications systems.

1.2 RELATED DOCUMENTS

A. The latest versions of the following codes, standards, and guidelines shall be followed.

B. The following codes, as required by law:
1. National Electric Code (NEC)

C. The following standards:
1. ANSI/TIA-569-D Telecommunications Spaces and Pathways
2. NECA/BICSI 568-2006, Installing Commercial Building Telecommunications Cabling

D. The following guidelines:
1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 SUBMITTALS

A. Product Data Submittals: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.

B. Product Information
1. Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.
2. Shop Drawings
a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support (where supported by cable tray vs. j-hooks). These locations are to be fully coordinated with all other trades.

C. The following submittals are due Post-Construction:
1. Record Drawings
a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.
2. Manufacturer and Maintenance Manuals for all installed equipment.
3. Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.

PART 2 - PRODUCTS

2.1 CABLE HOOKS (J-HOOKS)

A. Cable hooks shall:

1. Be listed by UL for installation into a plenum space.
2. Be specifically designed for telecommunications cables.
3. Bear a surface of sufficient width to comply with required bend radii of high- performance cables;
4. Have flared edges to prevent damage while installing cables.
5. Include a top latch to keep cable within the hook. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

B. Cable support sling shall:
1. Be constructed from steel and woven laminate
2. Have a static load limit of 100 lbs.

C. Manufacturer shall be:
1. Cooper B-Line, BCH Series
2. Erico, Cablecat Series
3. Panduit, J-Pro Series
4. Or approved equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. Follow all manufacturers' instructions.

B. Coordinate with all other trades prior to installation.

C. All telecommunications cabling not routed through conduit or cable tray shall be supported every 4' to 5'.

D. Telecommunications cables shall not be supported by any other trades and shall be fully-supported by independent methods.

3.2 CABLE HOOKS (J-HOOKS)

A. Cable hooks shall not be supported by ceiling grid support wires.

B. Where support wires are used, independent support wires shall be attached to the structural ceiling (above floor deck) on one end and to the suspended ceiling grid on the other end. The prior is meant to carry the load, the latter is meant to act as a "sway control".

C. Size cable hooks to allow for a maximum of 25% capacity to facilitate future installation of cables.

D. Cable hooks shall be installed such that cable slack between supports is a minimum of 6" above ceilings.

E. Provide adequate cable hooks to ensure telecommunications cabling is a minimum of 6" from light fixtures and power conduits.

F. Where telecommunications cabling is being supported with cable hooks, provide a cable hook at every change in direction.

G. Cable hooks shall be installed in a conveniently accessible location.

H. Route cabling such that a minimum of 48" is provided between cabling and electric motors or generators.

END OF SECTION

SECTION 27 05 34
CONDUIT, RACEWAYS AND BOXES FOR AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's/Project's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Section includes:
   1. Conduit
   2. Outlet boxes
   3. Floor boxes

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including, but not limited to, Divisions 0, 1, 11, 26, 27 and the general contract specifications.

B. Related specification sections:
   1. Section 274116 Audiovisual Systems

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway/junction box locations for equipment and routing of cables/raceway from equipment, terminal and pull boxes to system equipment racks and/or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
   1. Section 260526 – Grounding and Bonding for Electrical Systems
   2. Section 260529 – Hangers and Supports for Electrical Systems
   3. Section 260533 – Raceway and Boxes for Electrical Systems
   4. Section 078400 – Firestopping

1.5 DEFINITIONS:

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
   2. The terms "shall" is mandatory, "will" is informative, and "should" is advisory.
   3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
   4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
   5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
   6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
   7. The term "Professional grade" – Equipment that is intended for commercial use, not residential, use and is rated for continuous 24-7 use.

8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
9. The term "Labels" – refer to labels on audio-visual equipment as outlined in Section 3.4.
10. The term "OFE" refers to items that are Owner Furnished Equipment
11. The term "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Raceway and box systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
      a. International Building Code/BOCA National Building Code
      b. Local Governing Authorities Having Jurisdiction
      c. NFPA-72 National Fire Alarm and Signaling Code
      d. NFPA 101 Life Safety Code
      e. UL Listed- Underwriter's Laboratories Listed
   2. TIA Telecommunications Industry Association
      a. TIA-606-C Administration Standard for Telecommunications Infrastructure
      b. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
      c. EIA RS-310-C Racks, Panel, and Associated Equipment
   3. American Society For Testing and Materials Standards (ASTM)
      a. ASTM E814: Standard Test Method for Fire Tests of Through-Penetration Firestops.
      b. ASTM E2393-04 Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
   4. Underwriters Laboratories Inc. (UL):
      a. UL Qualified Firestop Contractor Program.
   5. UL Fire Resistance Directory -Volume 2:
      a. Through-Penetration Firestop Devices (XHJI)
      b. Fire Resistive Ratings (BXUV)
      c. Through-Penetration Firestop Systems (XHEZ)
      d. Fill, Void, or Cavity Material (XHHW)

1.7 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide box and conduit systems to support audiovisual connectivity as outlined in this specification and the TA drawing package.

1.8 SYSTEM(S) DESCRIPTION AND REQUIREMENTS

A. Provide raceway and outlet box system suitable for installation of Audio, Video, Voice and Data-based systems equipment and cabling by others.

1.9 SUBMITTALS

A. General: Submittals shall be provided according to project specific Submittal Procedures.

B. Manufacturer's Literature: Submit three copies of the manufacturer's technical data for the floor boxes to be used on this project.

1.10 QUALITY ASSURANCE

A. Labeling Requirements: Raceways, boxes and fittings shall be Underwriter's Laboratories, Inc. (UL) listed and labeled. UL listing and labeling will not be required if it can be shown that raceways and boxes meet the requirements of another nationally recognized testing laboratory (NRTL).

B. All required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Conduits raceways and boxes shall be constructed of the manufacturer's standard materials, as listed in published product information; types and sizes shall be as indicated or as required for both the installation and for NEC compliance.

B. Conduit and Raceways:
   1. Empty conduit, raceway and outlet box system shall comply with both this section as well as applicable electrical and telecommunications specification sections.
   2. Conduits shall be marked to identify the intended use. Color coding is acceptable, conduit numbering is preferred.
   3. Conduits shall be metallic EMT and or IMC unless otherwise approved in writing.
   4. Conduits used for audiovisual shall not be less than ¾" ID.
   5. All conduits shall have pull strings.
   6. All conduit stub ups shall be reamed and have protective bushings installed.
   7. Provide conduit sizes and connectivity as indicated on the audiovisual/TA drawings.
   8. Acceptable Products
      a. Allied Tube and Conduit
      b. Wheatland Tube
      c. Republic Conduit
      d. Wiremold
      e. Or approved equal

C. Outlet Boxes:
   1. 1 gang box – 2-1/8 inches deep by 2-1/8 inches high with 1 gang ring
   2. 2 gang box – 2-1/8 inches deep by 4-11/16 inches square with 2 gang ring
   3. 6" x 6" NEMA Type 1 enclosure
   4. 8" x 8" NEMA Type 1 enclosure
   5. 10" x 10" NEMA Type 1 enclosure
   6. 12" x 12" NEMA Type 1 enclosure
   7. Acceptable Products
      a. Cooper Industries
      b. Hubbell
      c. Steel City
      d. Wiremold
      e. Or approved equal

D. Floor Boxes:
   1. Shall comply with Electrical, Telecommunications, Architectural and section 27 41 16 requirements for location, configuration and connectivity.

2. Type: Unless otherwise indicated, floor boxes shall be fully adjustable, UL listed, CUL listed, scrub water approved and not less than 480 in3 in volume. Adjustment leveling feet shall provide 1/8 inch (minimum) vertical or angular (tilting) adjustment.
3. Box configuration: boxes shall have configurable compartments allowing for separated sections for power, data, and audiovisual connectivity.
4. Cover Plates: Unless otherwise indicated, cover plates for floor boxes shall be made of heavy steel not less than 11-gauge thick and each shall be provided with a 0.25 inch aluminum ring (SLP-type) or flange permanently attached to the adjusting ring.
5. Acceptable Products:
   a. FSR 500P-6
   b. Wiremold/Legrand EFB8S
   c. Or approved equal

E. Cover Plates
1. Comply with Architectural requirements for plate finish
2. Section 274116 and TA series drawings provide plate configuration details and specifications for all audiovisual specific plates and receptacles.
3. Provide blank plates for all box sections that are not utilized for day one use.
4. Acceptable Products:
   a. RCI Custom
   b. Leviton
   c. Hubbell
   d. Wiremold
   e. Or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install raceway and outlet box system continuous from outlet to junction box and to equipment location with no more than two 90-degree bends or more than four 45-degree bends (180 degrees total). A suitably sized pull box will be require in runs after 180 degrees of conduit bend.

B. Flexible conduits are not acceptable for audiovisual use.

C. Install raceway from outlet boxes to cable ladder in corridor as indicated. Bush and ream conduit ends and terminate with insulated bushings. Clamp conduit to ladder as required for proper support. Provide fittings.

D. Install raceway from outlet boxes to accessible ceiling spaces. Bush and ream conduit ends and terminate with insulated brushings.

E. Where cable tray/ladder is not utilized, make continuous runs from box to box with isolation from building systems as required.

F. Install boxes as indicated or as necessary, complying with the manufacturer's written instructions, applicable requirements of codes and standards, and according to recognized industry practices. Finished installation shall have a 4 hour minimum fire rating.

G. Adjustments: Under the following condition and with the approval of the Contracting Officer, move raceways and boxes from the shown location as follows:
1. Where box locations shown would interfere or cause associated electrical equipment to interfere with architectural, structural or mechanical features, install the box in a location which eliminates interference but with the smallest deviation from the location shown.

H. Knockouts: Open only knockouts which will be used for a conduit. Install tight fitting knockout closers in holes from which conduits have been removed.

I. Box Supports: Fasten raceways and boxes securely in place, using any approved spring clips and other fasteners, required in Section 260529 - Hangers and Supports for Electrical Systems

J. No Extension Rings: Install boxes which provide the required volume without the use of extension rings.

K. Masonry Boxes: Install masonry boxes where boxes are recessed in wood, concrete block or brick or wood paneling. Saw-cut the opening for the boxes so that they will fit snugly in the opening. Install boxes with front edges flush with adjacent surfaces.

L. Cast Metal Boxes: Install cast metal boxes with weatherproof covers under any of the following conditions:
   1. Exterior locations
   2. Where exposed to moisture
   3. In exposed rigid steel conduit systems

M. Boxes for Receptacles: Shall be equipped with a grounding terminal screw.

N. Communications Outlets: Install boxes for telephone, intercom, and public address outlets. A grounding terminal is not required for these boxes however boxes and conduits shall be bonded per NEC requirements.

O. Box Covers: Install box covers appropriate for the box, type of outlet and device, and with additional requirements as follows:
   1. For boxes recessed in gypsum wallboard, install raised device covers.
   2. For exposed, surface mounted boxes, install covers deep drawn 1/2 inch, with height and width dimensions identical to the associated box.
   3. Terminate and install plates specified in Section 262726 - Wiring Devices and per plans.
   4. For cast metal boxes, install gasketed, cast metal covers.

P. Care for Insulation: Replace any thermal insulation cut or damaged during installation of boxes.

Q. Floor Box Adjustment: Adjust floor boxes and covers so that cover plates are flush with the finished floor around the entire circumference.

R. Carpet Plates: In carpeted areas, install a carpet plate at each floor box.

S. Fire Stopping: Firestop systems shall be used in locations including, but not limited to, the following:
   1. Penetrations through fire resistance rated floor and roof assemblies including both empty openings and openings containing penetrants.
   2. Penetrations through fire resistance rated wall assemblies including both empty openings and openings containing penetrants.
   3. Membrane penetrations in fire resistance rated wall assemblies where items penetrate one side of the barrier.
   4. Joints between fire resistance rated assemblies.
   5. Perimeter gaps between rated floors/roofs and an exterior wall assembly.

3.2 EQUIPMENT AND WIRING

A. Furnishing and installing instruments, wires, equipment and connections will be by others.

END OF SECTION

SECTION 27 05 36

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. This Section specifies the requirements for the Cable Tray System for the Glenridge Middle School Project.

B. The Owner's/Project's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Provide all materials and labor for the installation of a permanent Cable Tray System as hereinafter identified and/or reflected per this document and the accompanying drawings.

B. Cable Tray Systems are defined to include, but are not limited to, horizontal and building backbone cable trays, ladder rack, supports, accessories, associated hardware and fire stopping materials specific to cabling for voice and data.

C. The primary horizontal cable support system will be cable tray, installed as shown in the TN drawings. Cable tray will be properly grounded. Wall penetrations shall transition to properly fire-stopped 1"- 4" sleeves, then back to cable tray.

D. Work furnished and installed by Electrical Contractor as specified in this Section and as shown in the TN drawings includes:
   1. Equipment/Telecommunications Rooms- cable tray and ladder rack installation.
   2. Overhead- Backbone and Horizontal Communication Pathways.
   3. Fire stopping of cable tray and conduit cable pathways.
   4. Bonding and grounding of overhead cable pathway system- cable tray/ladder rack, racks and cabinets within the ER/TRs.

E. Completely coordinate with work of other trades.

1.3 SECTION INCLUDES

A. Interior communications pathways and supports.

B. Risers in ER/TR(s).

C. Grounding and bonding of cable tray and components.

D. Cable Tray Pathway fire stopping requirements.

1.4 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Division 27 Sections include:
   1. 270526 Grounding and Bonding for Communications Systems
   2. 270528 Pathways for Communications Systems

3. 270529 Hangers and Supports for Communications Systems

1.5 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. The pertinent portions of the following specifications, standards, regulations and codes shall be incorporated by reference into these specifications.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Occupational Safety and Health Act (OSHA)
      d. NEMA VE 1 – Metallic Cable Tray Systems
      e. NEMA VE 2 – Cable Tray Installation Guidelines
   2. Communications:
      a. TIA-568.0-D Generic Telecommunications Cabling for Customer Premises.
      b. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard.
      b. TIA-569-D Telecommunication Spaces and Pathways.
      c. TIA-606-C Administration Standard for Telecommunications Infrastructure.
      d. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
      e. BICSI TCIM: BICSI Telecommunications Cabling Installation Manual.
      f. BICSI TDMM: BICSI Telecommunications Distribution Methods Manual.

1.6 DEFINITIONS

A. "EMT" shall mean Electrical Metallic Tubing.

B. "Raceway" shall mean any enclosed channel for routing wire, cable or busbars.

C. "TMGB" shall mean Telecommunications Main Grounding Busbar. There is typically one (1) TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

D. "TGB" shall mean Telecommunications Grounding Busbar. There is typically one (1) TGB per Telecommunications Room (TR). The TGB is connected both to the TMGB and to the building structural steel or other permanent metallic systems.

E. "TBB" shall mean Telecommunications Bonding Backbone. The TBB is a conductor used to connect TMGBs to TGBs.

F. "Pullbox" shall mean a metallic box with a removable cover, used to assist pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends. Pullboxes shall have no more than one (1) conduit entering and one (1) conduit exiting the box.

G. "Junction Box" shall mean a pullbox wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

A. The following is a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The Specifications and the Contract Drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.

B. Furnish, install, and place into adequate and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Cable Tray Infrastructure for Telecommunications Circuits as specified in the Contract Documents. The Cable Tray System

shall support an ANSI/TIA and ISO/IEC compliant Telecommunications Structured Cabling Systems.

C. The work shall include materials, equipment and apparatus not explicitly mentioned herein or noted in the Contract Document, but which are essential to make a complete working ANSI/TIA and ISO/IEC compliant Cable Tray System

D. Materials:
   1. Furnish and install at locations that show the specified equipment to provide a completely operational Telecommunications Cable Tray Distribution System without additional cost to the Owner.
   2. The following list of main items of the installation shall not be considered to be all-inclusive:
      a. Cable Tray Sections
      b. Connectors and Fittings
      c. Radius Drops
      d. Pull Boxes
      e. Hangers, supports, straps, and installation accessories for cable tray.

1.8 RELATED WORK

A. Conduits:
   1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays as specified in part within this specification and associated drawing set.

1.9 SUBMITTALS INFORMATION

A. Product Data Submittals: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.

B. Closeout Submittals:
   1. Records- Maintain at the project site a minimum of one set of Drawings, Specifications, and Addenda. Drawings shall consist of redline markups, specifications and spreadsheets.
      a. Document changes to the system from that initially shown from the Contract Documents, and clearly identify component labels and identifiers on Drawings.
      b. Keep Drawings current throughout the progress of construction. ("Current" is defined as not more than one (1) week behind actual construction).

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required for a complete, permanent Cable Tray for Communications System. Provide all incidental and or miscellaneous hardware not explicitly shown in the Contract Documents but that is required for an operational system.

B. Physically verify existing site conditions prior to purchase and delivery of materials.

C. Cable Tray components must be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.

D. For a given manufacturer, all components shall be part of a single cable tray product line-components shall not be intermixed between a manufacturer's cable tray product lines unless otherwise specified.

E. Cable Tray must be UL Classified if used as an equipment grounding conductor.

2.2 MATERIALS AND FINISH

A. Cable Tray (Welded Wire): Cable Tray shall be constructed of a welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete with all tray supports, materials, and supplementary and miscellaneous hardware required for a complete cable tray system.
   1. Finish: Carbon steel with electro-plated zinc galvanized finish.
   2. Width: 12" or as indicated on drawings. Where cable tray width is not shown in the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown in the Contract Documents) plus an additional 100% for future expansion.
   3. Depth: Minimum of two (2) inches.
   4. Mesh: 2 x 4 inches.
   5. Fittings: Fittings shall be field fabricated from straight sections using manufacturer-approved tools and in accordance with the manufacturer's instructions.
   6. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, cable tray shall be complete with bolted splicing hardware for grounding/bonding throughout the entire cable tray system.

B. Ladder Rack: (Telco Style) Ladder rack shall be manufactured from tubular steel. Stringers (sides) will be made from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness. Cross members (rungs) will be made from 1" wide by ½" high tubular steel with .065" wall thickness.
   1. Ladder rack (stringers) will be 9'-8½ "long. Cross members will be welded in between stringers on 9" centers beginning 4-1/4" from one end so that there are thirteen cross members per ladder rack. There will be 8" of open space in between each cross member.
   2. Ladder rack will be UL Classified for suitability as an equipment-grounding conductor only. Minimum combined cross-sectional area of the stringers will be 0.40 square inches. A label affixed to the side stringer of the ladder rack will identify the manufacturer, the UL Classification and the minimum combined cross-sectional area of the stringers.
   3. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, ladder rack shall be complete with bolted splicing hardware for grounding/bonding throughout the entire system.

2.3 FIRESTOPPING MATERIALS

A. Firestopping Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL1479 fire test in a configuration that is representative of the actual field conditions.

2.4 LABELING AND ADMINISTRATION

A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed and created by hand carried label maker or a computer/software-based label making system. Handwritten labels will not be acceptable.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and or regulations are more stringent, in which case the local codes and or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in Article 1.5 REFERENCES, above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during construction at no additional cost to Owner.

F. Install the communications pathways system in a manner ensuring that telecommunications circuits, when installed, will fully comply with the ANSI/TIA/EIA and other references listed in Article 1.5 REFERENCES, above.

G. Remove all surplus material and debris from job site and dispose of them legally.

3.2 INSTALLATION

A. Provide cable trays above suspended ceilings in corridors and as shown on the Contract Documents and in the MDF and IDF rooms for backbone cabling and horizontal distribution.

B. Cable trays shall be hung trapeze style. Center hung tray is unacceptable. The inside of the cable tray or wire way shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) shall have the portion within the tray protected with a smooth, non-scratching covering so that cable can be pulled without physical damage. When a wire way passes through a partition or wall, it shall be an unbroken length. Installation of telecommunications cables shall not exceed the fill requirements. Openings in fire-rated walls, floors and ceilings shall be properly fire stopped. Barriers between power and telecommunications cables shall be installed per electrical code. Cable trays and wire ways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.

C. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the applicable class as specified in the electrical code. A support should be placed within 600 mm (2 ft.) on each side of any connection to a fitting. Wire ways shall be supported on 1500 mm (5 ft.) centers unless designed for greater lengths.

D. Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
   1. Cable tray shall be installed plumb, level and square with finished building surfaces.
   2. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
   3. Cable tray elevation changes shall be gradual.

E. Cable Tray Routing:
   1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.

2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous or corrosive areas.

F. Cable Tray Clearance Requirements:
   1. Clearance requirements for cable tray accessibility:
      a. Maintain a clearance of 6" between top of cable tray and ceiling structure or other equipment or raceway.
      b. Maintain a clearance of 8" between at least one side of cable tray and nearby objects.
      c. Maintain a clearance of 6" between bottom of cable tray and ceiling grid or other equipment or raceway.
   2. Clearance requirements from sources of electromagnetic interference (EMI):
      a. Maintain a clearance of 6" or more from fluorescent lighting.
      b. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
      c. Maintain a clearance of 48" or more from motors or transformers.
      d. Pathways shall cross perpendicularly to electrical power cables or conduits.
   3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit.

G. Cable Tray Fittings: Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer's instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically called out on the Contract Documents.

H. Cable tray supports shall be provided according to the manufacturer's recommendations.
   1. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
   2. Where cable trays abut walls, provide wall-mounted supports.
   3. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
   4. Trays shall be supported at 5-foot intervals minimum, or more frequently if required by the manufacturer.

I. Load Span Criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.

J. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation.

K. Wire-type cable tray shall be cut with a manufacturer-approved cutter with "offset cutting blade" jaws and a minimum 24-inch handle.
   1. The choice and position of the jaws at the point where the cut is made shall allow shearing as close as possible to the intersection of the steel wires.
   2. Cuts shall ensure the integrity of the galvanic protective layer.

L. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where cable tray crosses building expansion joints in addition to where shown on the Contract Documents. Provide bonding jumper except where expansion joints are explicitly approved for bonding.

M. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and during normal occupancy and operation.

N. Barrier Strips: Provide barrier strips as recommended by manufacturer.

O. Radius Drops: Provide cable tray radius drops where cable trays cross other telecommunications cable trays or ladder rack in addition to where shown on the Contract Documents.

P. Slots/Sleeves: Provide slots/sleeves where required and where shown on the Contract Documents. Provide hammer drilling, core drilling and saw cutting where required for installation. Seal and firestop (firestop only if fire rated barrier) between slot/sleeve and cable tray.

3.3 GROUNDING AND BONDING

A. Grounding/Bonding: Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA standards and the references listed in Article 1.5 REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.

B. Bond metallic raceway (including cable tray) together and to the nearest TGB (as provided under Division 27 Section 270526 — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

C. Cable Tray Bonding Splices: Provide cable tray splices according to manufacturer requirements to create a continuous bonding conductor throughout the entire cable tray.

D. Bonding Conductors:
1. Bond distribution conduits to cable tray.
2. Provide bonding jumpers at expansion joints, sleeves and any other locations where electrical continuity is interrupted.
3. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

3.4 FIRESTOPPING

A. Only employees trained/certified by the fire-stopping manufacturer shall apply fire-stopping materials.

B. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
1. Provide fire stopping material for through and membrane penetrations of fire-rated barriers.
2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in Article 1.5 REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
4. For demolition work, apply fire stopping to open penetrations in fire rated barriers where cable is removed. Apply fire stopping regardless of whether the penetrations are used for new cable or left empty after construction is complete.
5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/ re-enterable.

3.5 CLEANING AND PROTECTION

A. After completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

3.7 LABELING AND ADMINISTRATION

A. Provide the following two labels, alternating one label every 10 feet, along the entire length of the cable tray:
   1. Label #1: Label shall read "TELECOMMUNICATIONS/LOW VOLTAGE CABLING ONLY".
   2. Label #2: Label shall read "WARNING! CABLE TRAY SERVES AS A TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT DISCONNECT!"

END OF SECTION

SECTION 27 05 43

UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Provide all services, labor, materials, tools, and equipment necessary for the complete and proper installation of exterior telecommunications pathways as specified in the contract.

B. This section includes the minimum requirements and installation methods for the following:

1. Underground Conduit systems.
2. Horizontal Drilling (commonly referred to as Directional Boring or Horizontal Boring).

1.2 QUALITY ASSURANCE

A. Installation for all exterior telecommunications pathways shall be performed in a professional and workmanlike manner. All construction methods that are not specified in the Contract Documents shall be subject to the control of Owner.

B. Equipment and materials shall consist of the quality and manufacturer indicated in the contract. The equipment specified is based on the acceptable manufactures listed in the contract.

C. Materials and work specified herein shall conform with the applicable requirements of:

1. ANSI/NFPA 70
2. IEEE/NESC
3. NEMA
   a. NEMA, RN1, PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   b. NEMA, TC3, PVC Fittings for use with Rigid PVC Conduit and Tubing.
   c. NEMA, TC6, PVC and ABS Plastic Utilities Duct for Underground Installation.
   d. NEMA, TC8, Extra Strength PVC Plastic Utilities Duct for Underground Installation.
   e. NEMA, TC9, Fitting for ABS and OVC Plastic Communications Duct and Fittings for Underground Installation.
   f. NEMA, TC10, PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
4. UL Standards
   a. UL 6 Rigid Metal Electrical Conduit
   b. UL 651 Schedule 40 and 80 PVC Conduit
5. ANSI-C80.2 Specification for Rigid Steel Conduit, Enameled.
6. TIA-569-D Telecommunications Spaces and Pathway.
7. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
8. TIA-758-B Customer Owned Outside Plant Telecommunications Infrastructure Standard.
9. BICSI TDMM Telecommunications Distribution Methods Manual
10. BICSI Outside Plant Design Reference Manual

D. For horizontal drilling, the Contractor shall follow all safeguards necessary to ensure that crucial aspects of proper directional bore installation are controlled.

E. Personnel for horizontal directional drilling shall be fully trained in their particular duties as part of the drilling team.

PART 2 - PRODUCTS

2.1 CONDUIT SYSTEM

A. Non-Metallic Conduit:
   1. PVC plastic pipe, ASTM D1785, Schedule 40 or 80, Type PVC 1120
   2. 4" 45 Degree Fiberglass Bend: FRE Composite Inc., 30-4032 Elbow IPS
   3. 4" 90 Degree Fiberglass Bend: FRE Composite Inc., 30-4030 elbow IPS

B. Metallic Conduit: GRC with PVC coating (for building entrances, offsets and sweep bends) within 50 feet of the building protection.

C. Conduit Joint Couplings:
   1. PVC non-metallic fittings must be installed with solvent applied couplings.
   2. Approved transition couplings shall be used to connect metal to plastic (PVC) conduits.
   3. Couplings shall be threaded and or glued to provide a watertight seal at conduit junctions.

D. Outside Pull-Box: Minimum 14-gauge galvanized steel with weatherproof locking cover and hardware surface mounting as specified in the contract. Dimensions as specified in the contract.

2.2 CABLE ROUTING HARDWARE

A. Cable Rack with Support Hardware as Required

B. Cable Rack Steps/Hooks

2.3 HORIZONTAL DRILLING EQUIPMENT

A. The horizontal directional drilling equipment shall have a drilling device of appropriate capacity to perform the bore; it shall have a guidance system to precisely guide boring operations, and trained personnel to operate said system.

B. All equipment shall be in good, safe operating condition with appropriate supplies, materials and spare hardware on hand to preserve the systems integrity during the project.

C. The directional drilling apparatus shall consist of hydraulically powered system to drill into the earth at a variable angle.
   1. The apparatus shall be anchored to the ground in order to withstand any pressures required to complete boring.
   2. The hydraulic system shall be free of leaks.
   3. The hydraulic power system shall be self-contained with necessary pressure and volume to power the drilling operation.

D. The Guidance System shall be a proven type and shall be assembled and operated by personnel certified and experienced with this system.
   1. The operator shall be aware of any magnetic anomalies and shall consider these influences in the operation of the guidance system, if using a magnetic system.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which the new exterior telecommunications pathways are to be installed. Provide notification, in writing, of conditions detrimental to proper completion of the work.

B. Beginning of telecommunications pathway indicates Contractor acceptance of existing conditions.

3.2 TRENCHING AND BACKFILL

A. Perform all trenching and backfill for new underground conduit system placement as reflected in the Contract Documents.

B. Perform pavement removal and replacement as specified.

C. Perform pavement marking as required and specified.

D. All utilities to be located by contractor and exposed, if necessary, prior to construction.

3.3 CONDUIT SYSTEM PLACEMENT

A. Place new conduit system including hand-holes and manholes as reflected in the Contract Documents.

B. No pathways shall have more than 180 degrees of bends.

C. Twelve-inch (12") clearance from all utilities is to be preserved. If not possible conduit to be encased in concrete where proper distance cannot be achieved.

D. Telecommunication ducts shall cross below gas piping.

E. All conduits must be cleaned thoroughly prior to installation.

F. During construction all ends of conduit shall be plugged to prevent water and other materials from entering conduits, manholes and buildings.

G. New and reopened trenches located under asphalt roadways shall have concrete cap or be encased in concrete.

H. Seal all conduit junctions and fittings watertight prior to pouring concrete.

I. Unless otherwise noted on the Contract Documents a minimum of 24" depth shall be required above conduits.

J. Transition to PVC conduit five feet (5') from building outside wall penetrations.

K. Bury underground plastic line marker one foot (1') above telecommunications conduit.

L. The new conduit shall extend through the wall into the building, tunnel, or crawl space a minimum of 4".

M. Hand-holes shall be placed with the long dimension in line with the conduit run. The conduit shall enter opposite ends of the short sides so that the hand-hole shall not be used as a 90-degree bend during cable installations.

N. All conduits entering bottom of hand-hole shall be flush with the inside wall. Dirt shall be removed 6" below the bottom of conduits entering the hand-hole and pea-gravel shall be placed on the bottom to aid water dissipation.

O. The ends of all metallic conduits shall be reamed and bushed.

P. Plug ends of new conduit with watertight conduit plugs, removable conduit caulking compound, or conduit caps to ensure no foreign matter enters.

Q. All ducts and conduits entering a building must be sealed to prevent intrusion of liquids and gases.

Universal duct plugs are available in a variety of sizes for use in unoccupied ducts and conduits. In conduits where cable has been installed, conduits can be sealed using Foam Sealant, Putty, Cementitious Compounds, and Hydraulic Cement. All inner ducts entering a building must be fire stopped in accordance with ASTM E814 and UL 1479. The preferred method for sealing entrance conduits is Foam Sealant such as Polywater® Duct Sealant or equivalent.

3.4 HORIZONTAL DIRECTIONAL DRILLING

A. Owner Project Managers shall be notified 48 hours in advance of starting horizontal directional drilling. The drilling shall not begin until an Owner project manager is on site and agrees that the proper preparations for the procedure have been made.

B. No work shall commence until all Traffic Control and proper permits are in place as applicable for the specific operation.

C. Site Preparation:

1. Prior to any alterations to the work site, all entry and exit points shall be legibly marked.
2. No alterations to the work site beyond what is required shall be made.

D. Path Survey:

1. The entire drill pathway shall be precisely surveyed with entry and exit stakes placed at their appropriate locations within the areas reflected in the Contract Documents.
2. In the case of magnetic guidance systems, the drill pathway must be surveyed for any surface geomagnetic deviation and or anomalies.

E. All pertinent environmental regulations shall be observed.

F. Following drilling operations, all equipment shall be demobilized, and the work site returned to its original condition. All excavations shall be backfilled and compacted to 95% of original density. Landscaping shall be restored to its original site condition.

3.5 SAFETY

A. The contractor must comply with all Government regulations for asbestos, lead, and confined spaces.

B. All applicable federal and local safety regulations shall be adhered to and conducted in a safe manner.

C. Manholes shall be guarded per NESC C-2-1997, 423.A:

1. When covers of manholes, hand-holes, or vaults are removed, the opening must be protected with a barrier, temporary cover, or other suitable safeguard.

D. Test for gas in manholes and unventilated vaults per NESC C-2-1997, 423.b and C including but not limited to:

1. The atmosphere shall be tested for combustible or flammable gas before entry.
2. When combustible or flammable gases are detected, the work area must be ventilated and made safe before entry.
3. Unless utilizing continuous forced ventilation, a test must be made for oxygen deficiency.
4. Provisions shall be made for adequate continuous supply of air. This statement reflects evaluation of both the quantity and quality of the air.
5. No smoking shall be permitted in Manholes, Hand-holes, and or Vaults.
6. Where open flames may be used in Manholes, Hand-holes, or Vaults, extra precautions must be taken to ensure adequate ventilation.

E. All outside plant (OSP) construction must be fenced off and holes must be covered off hours and when not in use.

END OF SECTION

SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
   2. Grout.
   3. Silicone sealants.

B. Related Requirements:
   1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire- resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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.

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. Sleeves for Rectangular Openings:
   1. Material: Galvanized-steel sheet.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 GROUT

A. Description: Non-shrink; 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.

2.3 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.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. 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 pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "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 pathway or cable unless sleeve seal is to be installed
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
D. 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.
E. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION

SECTION 27 11 00 - COMMUNICATION EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Make available all services, labor, materials, tools, and equipment essential for the complete and proper installation within the Telecommunications Rooms (TRs) and the Equipment Rooms (ERs) as specified in the Contract Documents.

B. Section Includes:
   1. Backboards.
   2. Telecommunications Equipment Racks.
   3. Power Distribution Units.
   4. Grounding.
   5. Sleeve and Sleeve Seal Installation.
   6. Labeling.

C. Related Requirements:
   1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
   2. Section 271313 "Communications Copper Backbone Cabling" for copper backbone cabling, connecting hardware and cable identification systems.
   3. Section 271523 "Communications Optical Fiber Backbone Cabling" for fiber backbone cabling, connecting hardware and cable identification systems.
   4. Section 271513 "Communications Copper Horizontal Cabling" for voice and data cabling, connecting hardware and cable identification systems.

D. Completely coordinate with work of other trades.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. LAN: Local area network.
C. RCDD: Registered Communications Distribution Designer.

1.4 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 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.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer**,** qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Certificates: For equipment frames from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 BACKBOARDS

A. All walls of the TRs and ERs will be covered with rigidly fixed ¾" by 48" by 96" A/C grade fire - resistant or non-combustible plywood backboard, void free, 8' high, painted with two coats of light-colored fire-retardant paint if required. Field coordinate color with architect. Leave the Fire Rating seal exposed.

B. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.2 TELECOMMUNICATIONS EQUIPMENT RACKS

A. Manufactures: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Products (CPI).
2. Leviton Voice & Data Division.
3. Panduit.
4. Approved equivalent.

B. Floor-Mounted Racks: 2-Post, Modular-type, steel or aluminum 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.
3. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.

C. 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.

2.3 POWER DISTRIBUTION UNITS

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. Zero RU PDU, Single Phase, 120V Outlets, L5-30P Input Plug.
4. LED indicator lights for power and protection status.

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Telecommunications Bus Bar:
1. Connectors: Mechanical type, cast silicon bronze, solderless compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4-inch-thick by 2 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 TIA-607-C.

2.5 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 Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

2.6 LABELING

A. Comply with TIA-606-C 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.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with TIA-607-C.
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. 3 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.

3.3 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-C.
B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
C. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration including optional identification requirements of this standard.
D. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 27 11 16 – COMMUNICATIONS RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. The work covered in this section consists of the furnishing and installation of all necessary labor, supervision, materials, equipment, tests, and services to install communications racks, cabinets, frames and enclosures.

B. Related Sections:
   1. Division 27, Section 270526 "Grounding and Bonding for Communications Systems."

C. Standards and Codes References:
   1. EIA-310-D Cabinets, Racks, Panels and Associated Equipment.
   2. TIA-569-D and all addenda: Telecommunication Pathways and Spaces.
   3. TIA-607-C and all addenda: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
   4. TIA-606-C and all addenda: Administration Standard for Telecommunications Infrastructure.
   5. TIA-568.0-D and all addenda: Generic Telecommunications Cabling for Customer Premises.
   6. TIA 568.1-D and all addenda: Commercial Building Telecommunications Infrastructure Standard.

1.3 SUBMITTALS

A. Provide detail elevation drawings of each equipment rack in the TRs, ERs.

B. Provide manufacturer's literature and sample of telecommunications installation materials.

1.4 QUALITY ASSURANCE

A. Comply with the National Electrical Code (NFPA 70, "National Electrical Code").

B. Comply with TIA and BICSI installation manuals.

1.5 COORDINATION

A. Coordinate layout and installation of equipment racks with communications cabling installation, data switches, termination fields and patch panels, and all other equipment to mount inside the equipment rack.

B. Adjust arrangements and locations of equipment in ERs and TRs to accommodate and optimize arrangement and space requirements as approved by the EPA.

C. Coordinate with other sections as required ensuring that the entire work will be carried out in orderly, complete, and organized fashion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Comply with manufacturers and industry standards for installation of freestanding equipment racks.

2.2 EQUIPMENT

A. Equipment racks shall be standard two-post 84" Height (45 RU) by 29" Width (19") by 36" Depth and EIA/ECA-310-E compliant. Furnish and installed as shown in the drawings. Equipment racks shall be grounded per TIA standards and equipped with the following:
   1. Power strip with surge protection and have a minimum of 6-receptacle outlets on the power strip. Zero RU power strips are recommended.
   2. Vertical wire management extending the full height of the rack including both sides: front and back.
   3. Horizontal wire management as shown on the contract drawings.
   4. Equipment racks shall be placed so as to be accessible from both front and back.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify installation methods specified by the manufacturer prior to installation.

B. Ensure the equipment racks will fit the footprint allocated prior to attempting installation.

C. Securely fasten floor-mounted racks to the floor with anchors, expansion bolts, etc. Coordinate with structural engineer for proper type and use of bolts.

D. Consult a seismic engineer when seismic bracing is required.

E. Plan for the space needed for installation of both equipment and cable.

F. Plan for the equipment to be installed in the equipment rack. Ensure that the open space recommendations are adhered to for airflow between electronic equipment. Also ensure that is adequate space for cable so that bend radius and separation requirements are met.

3.2 GROUNDING

A. Attach a bonding conductor sized as defined in TIA-607-C and as defined by local code or the authority having jurisdiction (AHJ) between the Bonding Busbar and the equipment racks. The installer shall provide the bonding conductor and other necessary hardware required to make the connections between the equipment racks and the Bonding Busbar.

END OF SECTION

SECTION 27 13 13

- COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides the requirements for the installation of multi-pair unshielded twisted pair (UTP) cables and associated hardware for copper backbone cabling. Included in this section are the product requirements for cable, termination hardware and other required hardware. Installation practices and test requirements are also indicated in this section.

B. Contractor shall install all structural cabling elements in accordance with the most stringent requirements of the NEC, local building codes, TIA-568.0-D Generic Telecommunications for Customer Premises, TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard, ANSI/NECA/BICSI 568.2006 Standard for Installing Telecommunications Systems, and all relevant BICSI manuals including 13th Edition Telecommunications Distribution Methods Manual. Contractor must submit Drawings and receive approval from Owner's Project Manager for any deviations from standards or drawings due to field conditions.

C. Completely coordinate with work of other trades.

1.2 REFERENCES

A. NFPA 70 National Electric Code.

B. Authority Having Jurisdiction (AHJ).

C. Local Building Codes.

D. UL® Standard 910 "Test method for fire and smoke characteristics of cable used in air handling spaces." Provide products that are UL® listed and labeled for such use. UL® testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program. UL® Standard 1666 "Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts."

E. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance ANSI/TIA/EIA, including associated Addenda:
   1. TIA-568.0-D Generic Telecommunications Cabling for Customer Premises.
   2. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard.
   2. TIA-568-C.2 Balanced Twisted Pair Telecommunications Cabling and Components Standard.
   3. TIA-569-D Telecommunications Spaces and Pathways.
   4. TIA-606-C Administration Standard for Telecommunications Infrastructure.
   5. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
   6. TIA-758-B Customer Owned Outside Plant Telecommunications Infrastructure Standard.

F. National Electrical Manufacturers Association (NEMA).

G. ANSI/NECA/BICSI 568-2001 Standard for Installing Commercial Building Telecommunication Cabling.

H. American Society for Testing Materials (ASTM).

I. Institute of Electrical and Electronic Engineers (IEEE).

1.3 SUBMITTALS

A. Product Data:
   1. The contractor shall submit product data sheets and samples for all products specified under this section.
   2. Products requiring submittals shall include but not limited to the following:
      a. All cabling and wire.
      b. Patch Cables.
      c. All connectors and required tools.
      d. All termination system components for each cable type.
      e. All equipment room and telecommunications room horizontal cable management.
      f. All grounding system components.
      g. All firestop systems (including manufacturer published installation requirements).
      h. All cable raceway and support hardware.
      i. Other apparatus required for a complete and functional system.
   3. Products requiring samples shall include but not limited to the following:
      a. All cabling and wire.
      b. Patch Cables.
      c. All connectors and required tools.
      d. All termination system components for each cable type.
      e. All equipment room and telecommunications room horizontal cable management.
      f. All grounding system components.
      g. All firestop systems (including manufacturer published installation requirements).
      h. All cable raceway and support hardware.

B. Drawings:
   1. The contractor shall submit Drawings.

C. Project Closeout Test Data:
   1. The contractor shall provide test documentation.

D. As-Built Documentation:
   1. The contractor shall submit as-built documentation.

E. Warranty:
   1. The contractor shall provide a warranty.

PART 2 - PRODUCTS

2.1 CABLE

A. 4-Pair Category 6:
   1. 4-pair count cable shall be comprised of 23 AWG twisted pair copper conductors and sheathed in a PLENUM rated thermoplastic outer jacket. Pairs shall be color coded in accordance with ANSI/ICEA S-80-576.
   2. Cable jacket material shall conform to Article 800 NEC for use as plenum or non- plenum cables. Cables shall be UL® type CMP (PLENUM) and/or UL® listed for fire safety.
   3. Cable shall meet or exceed TIA-568-C.2 for Category 6 compliance.

2.2 PATCH PANELS

A. Patch panel shall be high density such that 24-ports occupy one rack unit and 48 ports occupy two rack units.

B. Patch panel shall use Category 6, RJ45 jacks in 6- or 8- port modules.

C. Patch panel jack (UMJ 8 position/8 conductor) shall terminate to a 110D-type insulation displacement contact, printed circuit board, to lead frame-mounted connector.

D. Patch panel jack shall be universal modular jack, 8 position, un-keyed unless noted otherwise.

E. Patch panel jack shall support termination of 22, 23, 24 and 26 AWG solid conductor, four-pair, and unshielded twisted pair copper cable.

F. Patch panel shall have rear-mounted cable management bar to ensure proper bend radius and strain relief for cabling.

G. Patch panel shall have the ability to accept color-coded identification tabs and port protecting shutters.

H. Patch panel shall be compliant with TIA-606-C labeling specifications.

2.3 SUPPORTING HARDWARE

A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.

B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

PART 3 - EXECUTION

3.1 GENERAL

A. The backbone cabling systems shall provide interconnections between telecommunications rooms, equipment rooms and entrance facilities. The system includes backbone cables, intermediate and main cross-connects, mechanical terminations used for backbone cross-connects.

B. Specified pulling tensions and bend radius shall be used in the installation of cables.

C. The proximity of backbone cabling to potential sources of RFI and EMI shall be considered when installing cable.

1. Maintain at least 6 inches of clearance away from fluorescent lighting fixtures and electrical conductors up to two kVA.
2. Maintain at least 24 inches of clearance away from electrical conductors up to five kVA.
3. Maintain at least 36 inches of clearance away from electrical conductors more than five kVA.
4. When cabling is required to cross over electrical conductors, they must do so at a 90-degree angle.
5. Electrical cabling is not permitted to lie on top of communication cabling.

D. The contractor shall bond both ends of all cable shields to the appropriate TGB/TMGB.

E. All cabling shall be labeled per specifications; no handwritten labels will be acceptable.

F. All backbone cabling shall be run with no splices.

G. Contractor shall adhere to TIA/EIA 568/569 specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.

3.2 INSIDE PLANT CABLE

A. The backbone cabling shall be configured in a logical star topology.

B. The backbone shall be limited to no more than two hierarchal levels of cross-connects. No more than one cross-connect may exist between a main and a horizontal cross-connect and no more than three cross-connects may exist between any two horizontal cross-connects.

C. The distance between the terminations in the entrance facility and the main cross-connect shall be documented by the Contractor and shall be made available to the access provider.

D. Riser cable shall be supported on every other floor using cabling manufacturer approved supporting hardware.

3.3 PATCH CABLES

A. Patch color codes are determined by their application. Patch cord color and quantity shall be coordinated with Owner Project Manager.

B. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

3.4 TESTING

A. Inside Plant Cable:
   1. Testing of all copper wiring shall be performed prior to system cutover. 100 percent of the horizontal, riser and inter-cabinet wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
   2. Multi-pair cables shall be tested to each TR. The cable runs shall be tested for conformance to the specifications of TIA-568-C.2.
   3. Testing shall include length, mutual capacitance, characteristic impedance, attenuation, and near-end and far end crosstalk. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor or replaced at no cost to Owner.
   4. Test equipment shall be specifically rated for the cabling being tested, properly configured, and calibrated per manufacturer's requirements.
   5. Contractor shall submit current calibration certificate(s) for each piece of test equipment to be utilized. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
   6. No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to Owner in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically, the Contractor shall provide one copy of software and appropriate license with the test data.
   7. Each test shall be given a test identification number. For high pair count UTP backbone cables, the cable identification shall be used as the test identification. High-count UTP backbone cables shall be divided into 1-pair increments and each shall have a unique test identifier.
   8. Test data shall be organized and grouped by individual Telecommunications Room (TR) with the summary report followed by a detailed test sheet for each cable tested. All results shall be sorted by test identification numbers and bound in 3-ring binders (no larger than three (3) inches thick each).
   9. Project closeout test report shall include the following:
      a. Installation company name, contact information, project manager and installation supervisor name.
      b. Project scope including project start and end dates, building name and address, floors where installation work was completed.

c. Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections terminated. List any special or unique information regarding site conditions.
d. 4-pair cable testing data including, at a minimum, test identification, cable length, pass/fail, test parameter title, test data and test time.
e. Installation Contractor Warranty.
f. Structured Cabling Manufactures Warranty.
g. As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
h. Elevation and plan view drawings for cabinet and rack elevations.

10. Acceptable copper test sets:
    a. Fluke.
    b. Engineer approved equal.

END OF SECTION

SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides the requirements for the installation of a fiber optic backbone system. Included in this section are the product requirements for the fiber optic cables, termination hardware and required support apparatus. In addition, installation and testing requirements for fiber optic systems is included in this section.

B. Contractor shall install all structural cabling elements in accordance with the most stringent requirements of the NEC, local building codes, TIA-568.0-D Generic Telecommunications Cabling for Customer Premises, TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard, TIA-568.3-D Optical Fiber Cabling and Components Standard, TIA-598-D Optical Fiber Cable Color Coding, ANSI/NECA/BICSI 568.2006 Standard for Installing Commercial Building Telecommunications Cabling and all relevant BICSI manuals including 13th Edition Telecommunications Distribution Methods Manual. Contractor must submit shop drawings and receive approval from Owner for any deviations from standards or drawings due to field conditions.

C. Completely coordinate with work of other trades.

1.2 REFERENCES

A. NFPA 70 National Electric Code.

B. Authority having jurisdiction (AHJ).

C. Local Building Codes.

D. UL® for wiring: UL® Standard 910 "Test method for fire and smoke characteristics of cable used in air handling spaces." Provide products that are UL® listed and labeled for such use. UL®" testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program. UL® Standard 1666 "Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts."

E. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance ANSI/TIA/EIA, including associated Addenda:
   1. TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
   2. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard
   3. TIA-569-D Telecommunications Pathways and Spaces
   4. TIA-606-C Administration Standard for Telecommunications Infrastructure
   5. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
   6. TIA-758-B Customer-Owned Outside Plant Telecommunications Infrastructure Standard
   7. TIA-526-7-A Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
   8. TIA-526-14-C Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
   9. TIA-598-D Optical Fiber Cable Color Coding.

F. National Electrical Manufacturers Association (NEMA).

G. ANSI/NECA/BICSI 568-2006 Standard for Installing Commercial Building

Telecommunications Cabling.

H. American Society for Testing Materials (ASTM).

I. Institute of Electrical and Electronic Engineers (IEEE).

1.3 SUBMITTALS

A. Product Data:
   1. The contractor shall submit product data sheets and samples for all products specified under this section.
   2. Products requiring submittals shall include but are not limited to the following:
      a. All cabling and wire.
      b. Patch cables.
      c. All connectors and required tools.
      d. All termination system components for each cable type.
      e. All equipment room and telecommunications room cable management.
      f. All grounding system components.
      g. All firestop systems (including manufacturer published installation requirements).
      h. All cable raceway and support hardware.
      i. Other apparatus required for a complete and functional system.
   3. Products requiring samples shall include but not limited to the following:
      a. All cabling and wire.
      b. Patch cables.
      c. All connectors and required tools.
      d. All termination system components for each cable type.
      e. All equipment room and telecommunications room cable management.
      f. All grounding system components.
      g. All firestop systems (including manufacturer published installation requirements).
      h. All cable raceway and support hardware.

B. Drawings:
   1. The contractor shall submit shop drawings and cable riser diagrams.

C. Project Closeout Test Data:
   1. The contractor shall provide test documentation.

D. As-Built Documentation:
   1. The contractor shall submit as-built documentation.

E. Warranty
   1. The contractor shall provide a warranty.

PART 2 - PRODUCTS

2.1 CABLE

A. 50µm OM4 Fiber Optic Tight-Buffered Interlocking Armored Cable
   1. 50µm multimode fiber optical cables shall have the following features:
      a. All optical fiber cables shall be factory-fabricated, low-loss, glass-type fiber optic multimode step index cables with the following operational and construction features.
         1) Tight Buffered Interlocking Armored Plenum Rated 12 Strand OM4 Cable.
         2) Aqua color-coded cable jacket.
         3) Used for vertical applications in buildings.
         4) UL® listed type of OFNR (riser) and OFNP (plenum). All cables shall conform

to Article 800 NEC.

5) Legacy support: Ethernet, Fast Ethernet, Token Ring, ATM, FDD.

b. Where armored cable is called for, cable shall be protected by flexible metal armor.

c. Where indoor/outdoor cable is called for, cable shall be specifically rated for indoor and outdoor use and shall include UV-resistant flame-retardant outer jacket and dry water blocking compound.

2. Multimode fiber optic cables shall meet the following specifications:

Core Diameter:	50µm
Fiber Category:	OM4
Fiber Strand Count:	12
Tensile Strength Elements and/or Armoring – Layer 1	Water-swellable Strength Members
Inner Jacket Material	Flame-retardant, UV Resistant
Tensile Strength Elements and/or Armoring – Layer 2:	Interlocking Armor
Maximum Attenuation:	3.0 db/km
Minimum Overfill Launch (OFL) Bandwidth	3500 MHz*km / 500MHz*km
Minimum Effective Modal (EMB) Bandwidth	4700 MHz*km
RoHS:	Free of Hazardous Substances According to RoHS 2011/65/EU
Outer Jacket Material	Flame-retardant, UV Resistant
Jacket Color:	Aqua

3. Acceptable manufacturers and products:
   a. Corning Cabling Systems
   b. Optical Cable Corporation
   c. Or approved equal

2.2 CONNECTORS

A. Multimode Connectors:
   1. LC Type:
      a. All multimode cables are to be terminated with LC-duplex type connectors at each end of each strand unless specified otherwise. Multimode LC connectors must have the following features:
         1) LC connectors shall meet TIA-568.3-D Optical Fiber Cabling and Components Standard.
      b. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
      c. Acceptable manufacturers and products: Corning Cabling Systems or approved equal.
   2. Connector Parameters
      a. Multimode connectors shall meet the following specifications:

Parameters	**Multi-Mode**
Interconnection Compatibility	LC Connectors
Insertion Loss	Max: 0.5 dB typical Typical: 0.1 dB
Reflectance (Connector)	-26 db
Durability	500 rematings <0.20 dB change
Tensile Strength- Jacketed Cable	11 lb., ≤ 0.20 dB change
Temperature Cycling	-40°C to +75°C, 21 cycles, <0.30 dB change
Material	Ferrule: Ceramic Housing: Composite
Boot Color	Aqua

2.3 TERMINATION HARDWARE

A. Contractor shall provide and install fiber optic patch panels as indicated on drawings.

B. 12 Port Fiber Optic Termination Shelves.
   1. 12 port fiber optic Fiber Termination Shelves are to have the following features:
      a. 12 port.
      b. 1 RU height Maximum.
      c. 19" rack mountable.
      d. Front loading panels.
      e. Fully loaded bulkheads as required.
      f. Comply with ANSI/TIA/EIA-606-A Labeling.
      g. Front cable management rings for patch cord slack.
      h. Acceptable manufacturers and products: Corning Cabling Systems or approved equal.

2.4 FIBER OPTIC PATCH CABLES

A. Multimode
   1. Provide 20 each 50-Micron OM4 dual or duplex (with identifying markings), non-keyed LC-Type fiber optic patch cords with 3-meter length.
   2. Fully compatible with OM4 50 Micron Fiber Optic Risers and Patch Panels.
   3. Color: Aqua.
   4. The contractor shall provide each of the following patch cords to the Owner Project manager at such time as required for Owner installation of network and/or workstation equipment.
   5. All patch cords are to be factory fabricated.
   6. All patch cords are to be the recommended series intended by the manufacturer to integrate with the installed cable segments and termination hardware. All patch cords are to be manufactured by the same vendors as the optical fiber cable and hardware.

7. Contractor shall provide patch cords in the quantities indicated in the drawings. Contractor shall provide a schedule of all cords indicating the planned lengths, quantities and colors to Owner for approval prior to placing any orders for cords.

2.5 SUPPORTING HARDWARE

A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.

B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

PART 3 - EXECUTION

3.1 GENERAL

A. Optical fiber cabling shall be provided between facilities and furnished with the quantity of fibers as designed on the contract drawings- 12 OM4 MMF. All fiber cable runs shall be from the same manufacturer and shall be of the same type.

B. Design shall allow for migration of the pull-through, interconnect or splice implementation to a cross-connection implementation. Sufficient space shall be left in the telecommunications room to allow for the addition of patch panels needed for the migration of the pull-through, interconnect or splice to a cross-connection. Sufficient cable slack shall exist in the telecommunications room to allow movement of the cables when migrating to a cross-connection.

C. Fiber cable shall have enough cable slack at the termination point to allow for routing cable through the termination hardware and back to a work table for fiber terminations, plus an additional 3 meters.

D. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

E. Slack may be stored as either cable or unjacketed fiber. Slack storage shall provide bend radius control so that the cable and fiber bend radius limitations are not violated. Fiber slack shall be stored in a protective enclosure and slack cable may be stored on walls, cable trays or enclosures within the telecommunications.

F. All cabling shall be labeled per specifications.

G. All armored and non-armored fiber optic cable shall be run in conduit/innerduct. Multiple fiber cables may be run in a single conduit/innerduct.

H. Contractor shall adhere to TIA 568/569 specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.

I. All fiber optic cabling shall be terminated with either LC connectors unless a vendor specific requirement requires a different type of connector for a specific and limited application. Coordinate final connector type determination with EPA's Information Technology representative. The following installation practices shall be followed:
   1. Fiber optic cable sheaths are not permitted to be deformed. Use only approved cable fasteners such as hook and loop.
   2. Do not pull fiber optic cabling with copper cabling.
   3. Do not exceed the fiber optic cable maximum pulling tension.
   4. In multiple fiber optic pulls, pull fiber optic cables of the same weight and design.
   5. Do not exceed the maximum pulling tension of the lowest rated fiber optic cable.
   6. Do not pull fiber optic cable over existing cables. Friction could be excessive and cause

damage.

7. Do not exceed maximum bend radius, both pulling and installed radius.
8. Do not pull fiber optic cable around sharp corners such as support brackets, rods, etc.
9. Protect fiber optic connectors when using pre-connectorized cables. Use approved pulling grips.
10. The use of lubricants is recommended for all fiber optic cable pulls. Lubricants should be approved for use with the fiber optic cable type. Never use detergent based lubricants when installing loose tube fiber optic cable.
11. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

J. Non-armored fiber optic cables installed within conduit shall be protected by using innerduct. If fiber optic cable is to be installed in conduit without any innerducts, the installer shall install innerducts to sectionalize the conduit. Each innerduct shall have pull tapes/line in each empty innerduct.

K. Fiber optic cables are not permitted to provide support for other cables or hardware. Never secure other cables or hardware to fiber optic cabling.

L. Cable that is individually supported may be taped or tied together every 3 meters for cable management but not for support.

M. When routing fiber optic cabling along walls to the termination or splice enclosure, protect fiber optic cabling by installing in innerduct. Place fiber optic warning signs along innerduct. Ensure there is enough cable slack to be able to be able to move the fiber optic termination hardware to any potential installation area in the room.

N. Fiber optic cabling termination shall follow the TIA 598 color code chart. To retain the correct polarity through the cabling system, the correct fiber polarity must be followed. Fiber cabling must be installed to pair an odd-numbered fiber with the next sequential even-numbered fiber. Each fiber pair shall be installed in a pair crossover orientation. Off-numbered fibers at position A at one end are at position B at the other end. Even-numbered fibers are at position B at one end and position A at the other end.

3.2 INSIDE PLANT FIBER

A. Riser cable shall be supported on every floor using cabling manufacturer approved supporting hardware.

B. Vertical fiber optic cable placement shall be installed by working from the top down when possible.

C. Install a split wire mesh support grip at the top of each run. Fiber optic cable shall have its own split wire mesh support grip at the top of the run.

3.3 PATCH CABLES

A. Patch color codes are determined by their fiber type. Match all patch cords to the installed fiber's OM rating.

B. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

3.4 TESTING

A. The contractor shall test all optical fiber cable prior to the installation of the cable. The contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.

B. Test equipment shall be specifically rated for the cabling being tested, properly configured, and

calibrated per manufacturer's requirements.

C. Loss Budget:
   1. Loss budget. Contractor shall provide calculations indicating the maximum loss budget for each fiber using the following formula.
   2. (Allowable cable loss per KM) * (KM of Fiber in Link) + (MFR Published Connector Loss) * (Number of Connectors) loss = Maximum Allowable Loss.
   3. The contractor shall provide loss budgets to Owner for review prior to testing.
   4. The contractor shall notify Owner in writing a minimum of 72 hours prior to the start of testing and provide a complete testing schedule to allow for witnessing of testing.
   5. The contractor shall submit calibration certificate(s) indicating that the test set(s) has been calibrated by the manufacturer. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
   6. End-to-end loss shall be less than the loss budget. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no cost to the Owner.

D. Test Data:
   1. No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to Owner in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically contractor shall provide one copy of software and appropriate license with the test data.
   2. Test data shall reflect the Owner labeling scheme.

E. Multimode:
   1. Testing shall be performed on all fibers in the completed end to end system. Testing shall consist of a bi-directional end-to-end system. Testing shall consist of a bi-directional end-to-end optical time domain reflectometry (OTDR) trace (all multimode strands over 100 meters) and bi-directional end-to-end light source-power meter test (all multimode strands). All tests shall be performed in accordance with TIA-568.3-D and TIA-526-14C. The system loss measurements shall be provided at 850 and 1300 nanometers for all fibers.
   2. Acceptable multimode fiber optic test sets:
      a. Noyes.
      b. Corning Cable Systems.
      c. Alcoa Fujikura.
      d. Tektronix.
      e. Engineer approved equal.
   3. Acceptable tests for light source-power meter testing of multimode fiber optic cables:
      a. Agilient Technologies.
      b. Corning Cable Systems.
      c. Fluke.
      d. Engineer approved equal.

F. Project closeout report shall include the following:
   1. Installation company name, contact information, project manager and installation supervisor name.
   2. Project scope including project start and end dates, building name and address, floors where installation work was completed.
   3. Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections

terminated. List any special or unique information regarding site conditions.

4. Fiber optic loss test data and OTDR test data including, at a minimum, test identification, pass/fail, test parameter title, test data and test time.
5. As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
6. Elevation and plan view drawings for cabinet and rack elevations.

END OF SECTION

SECTION 27 15 13

- COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pathways
   2. Unshielded twisted-pair (UTP) cabling
   3. Consolidation point
   4. Multi-user telecommunications outlet assemblies
   5. Cable connecting hardware, patch panels, and cross-connects
   6. Telecommunications work area outlets- faceplates and connectors
   7. Cabling system identification products
   8. Cable management system

B. Related Sections:
   1. Division 27 Section 271116 "Communications Racks, Frames and Enclosures" for voice and data cabling associated with system panels and devices.
   2. Division 27 Section 271313 "Communications Copper Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words or phrases, as used in the Drawings and/or the Specifications, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
   2. BICSI: Building Industry Consulting Service International.
   3. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.
   4. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
   5. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
   6. EMI: Electromagnetic interference.
   7. IDC: Insulation displacement connector.
   8. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
   9. LAN: Local area network.
   10. MUTOA: Multi-user telecommunications outlet assembly, a grouping in one location of several telecommunications' outlet/connectors.
   11. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
   12. RCDD: Registered Communications Distribution Designer.
   13. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.

14. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.
15. UTP: Unshielded twisted pair.

1.4 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 rooms. This cable and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

B. Category 6 unshielded twisted-pair cabling is used to provide connection to work area for both voice and data and wireless access points. Category 6A shielded twisted-pair cabling can be used to provide connection for AV applications, where specified.

C. TIA-568.1-D requires that a minimum of two telecommunications outlet/connectors be installed for each work area.

D. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.

E. Bridged taps and splices shall not be installed in the horizontal cabling.

F. A work area is approximately 100-150 sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

G. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (5 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (5 m) in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.2, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: Specification for each type of product is required.
   1. For cables, include the following installation data for each type used:
      a. Nominal OD.
      b. Minimum bending radius.
      c. Maximum pulling tension.

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. Cross-connects.
      b. Patch panels.
      c. Patch cords.
      d. Devices and cover plates.
   5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
   6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.

b. Clearances for access above and to side of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.7 QUALITY ASSURANCE

A. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of an RCDD.

B. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall always be present when Work of this Section is performed at Project site.

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. Telecommunications Pathways and Spaces shall comply with TIA-569-D and all TIA standards where applicable and all other related Codes.

E. Grounding and bonding shall comply with TIA-607-C and NEC where required.

F. Telecommunications Contractor qualifications: Comply with Project general requirements and additional requirements specified in this section or other sections. Prior to bidding, obtain and maintain all licenses required for system installation work required by the local Authority Having Jurisdiction (AHJ).

G. Product listing: Systems and equipment shall be listed and labeled by a nationally recognized testing laboratory (ETL, UL and/or NTRL) for compliance with referenced standards. All items of telecommunications system shall be listed as a product of a telecommunications system manufacturer under appropriate category by NRTL and shall bear appropriate label.

H. Materials and equipment: Materials and equipment shall be latest cataloged products of manufacturers regularly engaged in production and installation of telecommunications systems. Materials and equipment shall be manufacturer's latest standard design and comply with specification requirements.

1.8 TESTING REQUIREMENTS

A. During the installation process, all cables must be tested for accuracy and performance, and results documented.
1. Cabling Testing Requirement: Testing should be done according to TIA-568-C.2 for Category 6 and Category 6A using an appropriate Level testing instrument, to verify both the integrity of all conductors and correctness of the termination sequence.
2. Documentation: Documentation of cable testing shall be required, and the engineer shall be present during all tests. The cabling contractor shall provide a table of test results submitted with the as-built drawings. The table shall include:
a. All copper backbone terminated cables shall be tested for MHz sweep tests, continuity, Near End Cross Talk, and attenuation and the installed length.
b. The report shall indicate all defective pairs and test results of all pairs listed above. Cables not complying with TIA-568-C.2 shall be identified to the Project Manager for corrective action that may include replacement at no additional expense to the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials maintaining an orderly, clean appearance. If stored on site in open or unprotected areas, all equipment and material shall be kept off ground by means of pallets or racks and covered with tarpaulins.

B. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and

construction traffic. Wet materials will be unpacked and dried before storage.

C. Any material or workmanship found by the Owner or their Representative to be defective, inoperable, damaged or the like, the Vendor will replace at their own expense. According to BICSI ITSIM, cables should be tested upon receipt.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. All work put into place prior to Substantial completion shall be the responsibility of the Vendor to protect all equipment, racks, panels, cabling, terminations, etc. from damage, dust, dirt and debris, by an approved means.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and 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.

C. Coordinate cabling installation (especially cable tray location) with all other trades to avoid conflicts with other trades above the ceiling.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Pathways shall comply with TIA-569-D.

B. Cable Support shall be NRTL labeled for support of Category 6A 4-pair UTP cables, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:
      a. Chatsworth Products, Inc.
      b. Hoffman
      c. Cooper B-Line
      d. Any TIA approved equivalent
   2. Cable Tray Materials: 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 inch (0.055 mm) thick.
      a. Trough Cable Trays: Nominally 6 inches (150 mm) wide, unless otherwise noted on the contract drawings.
      b. Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
   1. Outlet boxes shall be no smaller than 4 11/16 inches (119 mm) square and 2-1/2 inches (64 mm) deep.

2. Refer to the electrical drawings for Tele/Data outlet locations including J-Boxes and conduit with pull string for all Tele/Data outlets.
3. Flexible metal conduit shall not be used

2.2 UNSHIELDED TWISTED-PAIR (UTP) CABLE

A. Description: Category 6, 100-ohm, 4-pair UTP cable, blue.
1. Comply with TIA-568-C.2 for performance specifications for Category 6.
2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
a. Communications Plenum Rated: Type CMP or
b. Communications Riser Rated: Type CMR

B. Description: Category 6A, 100-ohm, 4-pair UTP cable, orange.
3. Comply with TIA-568-C.2 for performance specifications for Category 6A.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
c. Communications Plenum Rated: Type CMP or
d. Communications Riser Rated: Type CMR

2.3 UNSHIELDED TWISTED-PAIR (UTP) CABLE TERMINATION HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2. Cables shall be terminated with connecting hardware of same category or higher.

B. Patch Panel: 48-ports Modular panels

1. Electrical Performance guaranteed to meet or exceed TIA-568-C.2 Category 6 specifications
2. Available in 24- and 48-port configurations (angled and straight) featuring universal A/B labeling
3. 110 connector terminations on rear of panel allow quick and easy installation of 22 to 24 AWG cable
4. Uses the Termination Manager for easier, faster, more reliable terminations and reduced variability in the placement and termination of cables to the panel.
5. Black powder covered high-strength steel panel comes equipped with a removable rear mounted cable management bar
6. Each panel comes ready to install, including front and rear labels
7. Intelligent Patch-Ready - field upgradable without the need to remove patch cords, meaning no network downtime
8. Can support network line speeds more than 1 Gb/s

C. Number of jacks per field: one for each four-pair UTP cable indicated.

D. Patch Cords: Provide and install one per port. Coordinate color and length with architect or building owner prior to ordering.

2.4 CONSOLIDATION POINTS

A. Not used in this project.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: CAT 6 100-ohm keystone, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.2.

B. Jacks and Jack Assemblies shall be modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

C. Workstation outlets: two (2) port-connector in a single faceplate.
1. Plastic Faceplate in common areas, and offices and most public places: High-impact plastic.

Coordinate color with Division 26 Section "Wiring Devices."

2. Metal Faceplate in mechanical, community, electrical and high use areas: Stainless steel complying with requirements in Division 26 Section "Wiring Devices."
3. For use with snap-in jacks accommodating, any combination of UTP, optical fiber, and coaxial work area cords.
4. Flush mounting jacks, positioning the cord at a 45-degree angle.
5. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Not used in this project.

A. UNSHIELDED TWISTED-PAIR CABLE (For Wireless Technologies)

A. Description: Category 6A, 100-ohm, 4-pair, shielded twisted-pair cable, orange.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.2 for performance specifications (Category 6A).
3. Shall meet the following specifications:
a. Maximum diameter of 7.239 mm (0.285 in)
b. Maximum DC Resistance of 9.38 Ohms/100m
c. Mutual Capacitance of 5.6 nF/100m @ 1 kHz
d. Nominal velocity of propagation (NVP) of 68%
e. Maximum operating voltage of 80V
f. Conductor gauge of 23 AWG
g. FTP construction consisting of a pair isolator, a core wrap, a shield and a drain wire.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
a. Communications Plenum Rated: Type CMP or
b. Communications Riser Rated: Type CMR

2.7 UNSHIELDED TWISTED-PAIR (UTP) CABLE TERMINATION HARDWARE (For Wireless Technologies)

A. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2. Cables shall be terminated with connecting hardware of same category or higher.

B. Patch Panel: 48-ports Modular panels
1. Electrical Performance guaranteed to meet or exceed TIA-568-C.2 Category 6A and ISO/IEC Category 6A/Class E specifications
2. Available in 24- and 48-port configurations (angled and straight) featuring universal A/B labeling
3. Simple-to-use grounding solution
4. Intelligent Patch-Ready - field upgradable without the need to remove patch cords, meaning no network downtime
5. High-strength steel panel comes equipped with a removable rear mounted cable management bar
6. Each panel comes ready to install, including front and rear labels
7. Can support network line speeds more than 1 Gb/s

C. Number of jacks per field: one for each four-pair cable indicated.

D. Jacks and Jack Assemblies: Shielded modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
1. Allows for multiple size cable terminations 0.270 inches up to 0.300 in. diameter over jacket and flame ratings: F/UTP and S/FTP
2. Universal design and label supports both T568 A & B wiring
3. Trade Agreements Act (TAA) compliant
4. Rugged, full-metal construction

5. IDC connector terminations on rear of base allow quick and easy installation of 22 to 24 AWG cable
6. Bonding and grounding at the jack located at the communications equipment room and at the work area shall be compliant with TIA-607-C.

E. Patch Cords: Provided and installed one per port. Coordinate color and length with architect or building owner prior to ordering.

2.8 AUTOMATED INFRASTRUCTURE MANAGEMENT (AIM)

A. Not used in this project.

2.9 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-C.

C. Comply with NEC Article 250, where required.

2.10 LABELING

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.11 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 COMMUNICATIONS EQUIPMENT ROOMS

A. Coordinate horizontal cabling installation with the General Contractor.

B. The General Contractor or Architect will provide a Communications Equipment Rooms layout.

C. Provide coordination directly with field technicians as required.

3.2 WIRING METHODS

A. Install cables in raceways, cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. The use of J-Hook is allowed if the ceiling spaces permits.
   3. Comply with requirements for raceways and boxes specified in Division 26 Section 260533 "Raceway and Boxes for Electrical Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. The use of Velcro type tie is recommended for bundling cables.

3.3 INSTALLATION OF PATHWAYS

A. WORK AREA OUTLETS: New construction WAO consists of one (1) 4-11/16" square by 2-1/4" deep flush mounted box. Each outlet box shall have an EMT conduit stubbed above the drop ceiling or extended into the hallway cable tray. Conduits size is as follows:
   1. For Outlets with three or less cables, use a 1" EMT conduit
   2. For Outlets with 3-6 cables, use a 1.25" EMT conduit
   3. For all other sizes, calculate fill ratio at 40% for proper sized conduit
   4. Where ceilings are accessible, the raceway and entrance end fitting shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
   5. Where ceilings are partially accessible, or if the Drawings and/or Specifications indicate installation of access panels, the raceway shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
   6. Where ceilings are inaccessible, or no ceilings exist, the raceway shall extend up as close to the ceiling as practical to allow installation of conduits as high as possible to the nearest hallway distribution system.

C. HORIZONTAL DISTRIBUTION SYSTEMS
   1. Conduit System (Renovations only, where conduit exists)
      a. Not applicable to this project.
   2. Cable Tray System
      a. Complete wall mounted, or suspended cable tray system and necessary accessories shall be provided as shown on plans. Install entire cable tray system in accordance with manufacturer's minimum installation practices and all local governing codes.
      b. Coordinate installation of cable tray with other trades to allow a minimum of 12" above, 12" in front, and 12" below of clearance from piping, conduits, ductwork, etc. Allowance must be provided for access to the tray with reasonable room to work. Obstructions to the tray must be minimized and cannot block more than 6 feet of the tray at any point in the run.
      c. Submittal drawings, in the form of 8 ½"x 11" catalog cut sheets, shall be pro-vided for the following items: cable tray, fittings, accessories and load data.
      d. Cable tray shall not be loaded beyond 60% of manufacturer's recommended load capacity.
      e. Install wall mounted cable tray on both sides of hallway as shown on drawings and where applicable.
      f. Where a new cable tray distribution system encounters a wall, install sufficient 4" EMT sleeves through the wall so cabling does not exceed 20% fill.
      g. Where cable tray is exposed below ceiling, install the appropriate solid bottom inserts to conceal cables.
      h. Install cable tray dropouts where large quantities of cables exit the distribution system.
      i. Cable tray must be sized to facilitate sufficient growth capacity for migration cable plant to coexist in same tray as existing cable plant, wherever possible.
   3. Communication Equipment Room Cable Tray System
      a. TR cable tray shall completely wrap all walls within the room. Cable tray shall extend over all equipment frames.
      b. Cable tray shall be a minimum width of 2" high x 12" wide unless otherwise noted. Cable tray may be sized upwards if fill ratio requirements need to be met based on cable quantities.
      c. All open pathway/trays shall be installed a minimum of six (6) inches away from any light fixture or other source of EMI (Electromagnetic Interference).
      d. All pathways shall be grounded per NEC Article 250.
      e. Provide external grounding strap at expansion joints, sleeves and crossover and at other locations where pathway/tray continuity is interrupted.
      f. Support all pathways from building construction. Do not support pathways from ductwork, piping, or equipment hangers.

g. Install cable tray level and straight unless noted on the construction drawings

4. Station Conduit: Station conduit is defined as conduit that originates at the WAO and rises within the walls or is exposed from a raceway and extends up into the drop ceiling or over to the hallway distribution system.
   a. Provide station conduits from WAOs to above the drop ceiling or extend over to the hallway distribution systems consisting of 1" EMT minimum or appropriate size as shown on the Drawings or as specified herein for installation of telecommunications cables.
   b. Provide an insulating press fit bushing on all telecommunications conduits including interconnecting nipples and stub to distribution system. To prevent conflicts with other cables or conduits to cable tray, the conduit shall be stubbed not less than 6" above or below conduit/cable tray centerline. Where space permits, every effort shall be made to bend station conduits down such that the flow of installed cables promotes the minimum length back to the TR and the least amount of bends in the cables. Bushings must be rated to be used in an environmental air handling space (Plenum).
   c. Provide measured pull line in 12" increments in each empty conduit to hallway distribution system.
   d. The use of 90-degree electrical pulling elbows is prohibited.
   e. Do not include more than two 90-degree bends between pulling points when in-stalling station conduit runs. If the path of the station conduits requires more than 180 degrees of total bends, installation of an appropriately sized junction box is required. See Division 26 Section "Raceway and Boxes for Electrical Systems for junction box requirements.
   f. Place an appropriately sized junction box in each individual station conduit run that exceeds 100 feet in length.
   g. The use of a third bend in a conduit is only acceptable if:
      1) The total conduit run is reduced by 15%.
      2) The conduit size is increased to the next trade size.
      3) One of the bends is located within 12" of the cable feed end.
5. Junction Box Requirements for Station Conduits
   a. If the station conduit route exceeds the 180 degree of total bends limitation, an appropriately sized junction box is required within a straight section of the conduit run.
   b. Each station conduit run requires a separate junction box. The sharing of a junction box by multiple conduits is prohibited.
   c. A junction box shall not be used in place of a bend. All junction boxes in station conduit paths shall be installed within a straight section of the conduit run.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA-568.0-D Generic Telecommunications Cabling for Customer Premises and TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard.
   2. Comply with BICSI ITSIM.
   3. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   4. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in TIA-568.1-D. Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

8. Do not splice cable between termination, tap, or junction points.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with TIA-568.0-D. Monitor cable pull tensions.

C. UTP Cable Installation:
1. Comply with TIA-568.0-D.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) 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 wire way or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil 6 feet (1800 mm) long of cable with a diameter coil of not less than 12 inches (300 mm) below each feed point.
4. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:
1. Comply with TIA-569-C and the BICSI TDMM for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
3. Separation between Communications Cables and Fluorescent Fixtures: A minimum of five inches (127 mm).

3.5 FIRESTOPPING

A. In all buildings, floor/ceiling assemblies, stairs, and elevator penetrations must be sealed with a 2-hour fire stop assembly at a minimum, unless otherwise noted.

B. Contact Owner's Representative to identify walls that are fire-rated construction. Walls must be sealed with a 2-hour fire stop assembly at a minimum.

C. Communication pathways requiring fire stopping shall utilize removable/re-usable fire stopping putties for ease of Moves, Adds, and Changes.

D. All fire stopping penetrations shall conform to the recommended practices listed in UL1479 or ASTM.

3.6 GROUNDING AND BONDING

A. Comply with TIA-607-C.

B. Install grounding according to BICSI TDMM.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) 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 no smaller than No. 6 AWG equipment grounding conductor.

3.7 LABELING

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. For wireless access points (WAP), cables shall be terminated on a separate panel and labeling shall follow the WAP location i.e. if WAPs are located on the second floor, the cabling shall be labeled WAP-201, WAP-202, etc.

C. For existing installation, labeling shall follow the existing scheme.

D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Furnish electronic record of all drawings, in software and format selected by Owner.

F. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   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 devices 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.
   5. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
   6. 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-606-C.

3.8 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Visually inspect UTP 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-568-C.2.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Cabling shall be tested as per clause 1.8 of this document.
   4. Test instruments shall comply with TIA-568-C.2. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration for UTP cabling and links for fiber optic cabling.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary

report that is formatted like what is proposed in the BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Final testing and system acceptance:
   1. Perform a walk thru with the RCDD that designed the system and observed all system testing.
   2. Provide three (3) sets of As-Built documents included in the Closeout documents.
   3. All certified test reports shall be evaluated before final acceptance of the system and final payment can be made.

END OF SECTION

SECTION 27 41 13

PROJECTION SCREENS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's/Project's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Section includes:
   1. Roll-up, electrically projected screens.
   2. Wall mounted front projection dry erase screens

B. Related sections:
   1. Section 05500 – Metal Fabrications: Metal rods, chains, bracing, fasteners and other support components for suspending projection screens.
   2. Section 06105 – Miscellaneous Carpentry: Wood blocking for installation of projection screens.
   3. Section 09260 – Gypsum Board Assemblies: Suspended gypsum board ceilings to contain recessed projection screens.
   4. Section 11061 – Theater Rigging: Coordinate installation with or around theater rigging systems. The screen and theater rigging systems shall not interfere with one another.
   5. Section 16400 – Electrical supply, conduit, and wiring for motorized projection screens.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including, but not limited to, Divisions 0, 1, 11, 26, 27 and the general contract specifications.

B. Related specification sections:
   1. Section 274116 Audiovisual Systems

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway/junction box locations for equipment and routing of cables/raceway from equipment, terminal and pull boxes to system equipment racks and/or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
   1. Section 260526 – Grounding and Bonding for Electrical Systems
   2. Section 260529 – Hangers and Supports for Electrical Systems
   3. Section 260533 – Raceway and Boxes for Electrical Systems

1.2 DEFINITIONS:

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:

1. "Gain" is the indication of screen's luminance or brightness measured perpendicular of screen center and measured relative to a block of magnesium carbonate which serves as the standard for 1.0 gain. Higher numbers indicate greater reflectiveness. Gain shall be determined in accordance with SMPTE RP 94-2000.
2. "Half gain viewing angle" is the angle from perpendicular center of screen at which the gain or brightness is decreased by 50 percent.
3. "Keystone" is the distortion of projected image when screen is not perpendicular with center line of projected image.
4. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
5. The terms "shall" be mandatory, "will" is informative, and "should" is advisory.
6. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
7. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
8. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
9. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
10. The term "Professional grade" – Equipment that is intended for commercial use, not residential, use and is rated for continuous 24-7 use.
11. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
12. The term "OFE" refers to items that are Owner Furnished Equipment
13. The term "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment

1.3 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Projection screens shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
      a. International Building Code/BOCA National Building Code
      b. Local Governing Authorities Having Jurisdiction
      c. NFPA-72 National Fire Alarm and Signaling Code
      d. NFPA 101 Life Safety Code
      e. UL Listed- Underwriter's Laboratories Listed
   2. Society of Motion Picture and Television Engineers (SMPTE):
      a. SMPTE RP 94-2000 - Gain determination of Front Projection Screens.

1.4 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide projection screens to support audiovisual systems as outlined in this specification and the TA drawing package.

1.5 SYSTEM(S) DESCRIPTION AND REQUIREMENTS

A. Provide projection screen systems coordinated with architecture, suitable for intended viewing application and projector location(s).

1.6 SUBMITTALS

A. Submit in accordance with Section 01330 – Submittal Procedures:
   1. List of proposed products and product data.
   2. Shop drawings showing dimensions, method of attachment, structural support, bracing, and electrical wiring.
   3. Samples of finishes for selection by Architect.
   4. Manufacturer's installation and maintenance instructions.

1.7 QUALITY ASSURANCE

A. Source limitation: Obtain projection screens from single manufacturer as a complete unit including necessary mounting hardware, motor, low voltage controls, limit switches, and accessories.

B. Motorized projection screens shall be certified for use in the United States by Underwriters Laboratory (UL), Inc. and shall bear UL label.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver projection screens until building is enclosed, other construction within spaces where screens will be installed is substantially complete and installation of screens is ready to begin.

B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Projection screens shall be constructed of the manufacturer's standard materials, as listed in published product information; types and sizes shall be as indicated and as required for both the installation and for NFPA compliance.

2.2 ACCEPTABLE PRODUCTS

A. Recessed ceiling mounted front projection screens.
   1. Da-Lite Large Deluxe Electrol
   2. Or approved Equal

B. Manufacturers of equivalent products submitted and approved in accordance with Section 01630 – Product Substitution Procedures.

2.3 MOTORIZED PROJECTION SCREENS

A. Type: Electrically operated projection screen for wall installation consisting of case, screen, motor, controls, electric brake, limit switches, mounting accessories, and other components necessary for complete installation.

B. Method of installation: Concealed in the ceiling.

C. Screen case: The case shall be aluminum extrusion. Bottom of case to be self-trimming with a built-in flange around the bottom of the case. Case to be white in color. A section of the bottom of the case shall be an aluminum door equipped with hinges so that it opens and closes automatically with the lowering and raising of the picture surface. The balance of the bottom of the case shall be a second hinged aluminum door manual opening to provide access. Hinges shall be mounted in a concealed way. To be complete with the three-button control switch with cover plate. **THE SCREEN CASE SHALL BE BLACK IN COLOR.**

D. Screen Operation: Electrically operated, UL and ULC listed, retractable, heavy duty, with rigid metal roller and motor housed within the roller. Bottom end of fabric to be inserted into a custom aluminum slat bar with added weight to provide vertical tension on the screen surface.

E. Roller: To be of rigid aluminum, 3" in diameter, mounted on vibration and noise absorbing supports.

F. Viewing surface securely attached to roller at top and at bottom to weighted dowel. The fabric shall be flame retardant and mildew resistant fiberglass with Matte White with black masking borders standard.

2.4 VIEWING SURFACE

A. Material
   1. Matt White vinyl surface laminated on woven fiberglass base and surface is washable with 1.0 gain.

B. Size of viewing surface / screen case:
   1. Cafeteria Commons location (PS1) 117.5"h x 188"w Case length 209" (16:10 Aspect Ratio) **THE SCREEN CASE SHALL BE BLACK IN COLOR**

C. Joints: Viewing surface shall contain no seams.

D. Edge treatment: 2 inches wide, black masking borders.

E. Black Drop: 24" of black drop. Verify with architect and site conditions prior to ordering.

2.5 MOTOR

A. Type: The screen shall have a single motor to operate the screen. Unit shall have a special designed motor mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent casting. To have pre-set, but adjustable limit switches to automatically stop fabric door in the "up" and "down" positions.

B. Mount outside screen roller on rubber vibration insulators.

2.6 CONTROLS

A. Provide 2 control points for each screen to lower, raise, stop and reverse projection screen at any point.
   1. Single station control: 3-button low voltage wall control
   2. AV Control panel(s).

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of projection screens with ceiling construction and related components penetrating or above ceilings such an s lighting fixtures, mechanical equipment, and ductwork and fire-suppression system.

B. Coordinate requirements for blocking, structural supports, and bracing to ensure adequate means for installation of screens.

C. Coordinate requirements for power supply conduit and wiring required for projection screen motors and controls.

D. Coordinate interface and installation of screen and masking controls with provision of video projector/projector control system.

E. Prior to installation, verify type and location of power supply.

3.2 INSTALLATION

A. Install projection screens and controls at locations and heights indicated on drawings.

B. Comply with screen manufacturer's written instructions and shop drawings.

C. Install screens securely to supporting substrate so that screens are level and back of case is plumb.

D. Provide required brackets, hanger rods and fasteners.

3.3 TESTING AND DEMONSTRATION

A. Test motorized projection screens to verify that screen, controls, limit switches, closure and other operating components are functional. Ensure that screen is level and viewing surface plumb when extended. Correct deficiencies.

B. Demonstrate operation of screen to Owner's designated representatives.

3.4 PROTECTING

A. Protect projection screens after installation from damage from construction operations. If damage occurs, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.

END OF SECTION

SECTION 27 41 16 - AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's and/or Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide and install complete and operational Audiovisual System(s) as outlined in these specifications and related drawings and documentation requirements as set forth in this documentation.
   2. It is the responsibility of the Contractor to provide all wiring, plates, connections, equipment, rigging, all support means and miscellaneous equipment for complete and fully operational System(s) if specified in this or other related documents or not.
   3. Included Spaces:
      a. Classroom Systems
      b. Gymnasium Systems
      c. Cafeteria / Stage
      d. Outdoor Recreation Systems

B. Provide for the coordination, provision, installation, inspection, testing, instruction, and warranties of the Audiovisual System(s).

C. Provide all materials, equipment, transportation, and necessary labor for a complete and operational Audiovisual System(s).

D. Additional contractor requirements:
   1. Required licenses, permits and low voltage permits including any required bonding or insurance requirements to comply with general conditions of specifications and contract documentation.
   2. Verification of the dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturers' recommendations.
   4. Submittal information and provisions.
   5. Documented Audiovisual System(s) testing procedures.
   6. Instruction of operating personnel.
   7. Manuals and provisions thereof.
   8. Maintenance and warranties.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including, but not limited to, Divisions 0, 1, 11, 26, 27 and the general contract specifications.

B. Related specification sections:
   1. Section 27 41 13 Projection Screens
   2. Section 27 05 33.1 Conduits, Raceways and Boxes for Audiovisual Systems

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway and/or junction box locations for equipment and routing of cables and/or raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
   1. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   2. Section 26 05 29 – Hangers and Supports for Electrical Systems
   3. Section 26 05 33 – Raceway and Boxes for Electrical Systems
   4. Section 26 09 43 – Addressable Fixtures Lighting Controls
   5. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.5 DEFINITIONS:

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
   2. The terms "shall" be mandatory, "will" is informative, and "should" is advisory.
   3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
   4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
   5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
   6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
   7. The term "Professional grade" – Equipment that is intended for commercial use, not residential, use and is rated for continuous 24-7 use.
   8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
   9. The term "Labels" – refer to labels on audio-visual equipment as outlined in Section 3.4.
   10. The term "OFE" refers to items that are Owner Furnished Equipment
   11. The term "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
      a. International Building Code and/or BOCA National Building Code
      b. Local Governing Authorities Having Jurisdiction
      c. NFPA-72 National Fire Alarm and Signaling Code
      d. UL Listed- Underwriter's Laboratories Listed
   2. IEC 60268-16 Third Edition 2003-05 Objective rating of speech intelligibility by speech transmission index
   3. AES:
      a. AES3-1-2009 (r2014): AES standard for digital audio
      b. AES5-2008 (r2013): AES recommended practice for professional digital audio

c. AES10-2008 (r2014): AES Recommended Practice for Digital Audio Engineering
d. AES14-1992 (s2014): AES standard for professional audio equipment
e. AES31-2-2012: AES standard on network and file transfer of audio - Audio-file transfer and exchange
f. AES47-Am1-2008: Amendment 1 to AES47 - AES standard for digital audio - Digital input-output interfacing - Transmission of digital audio over asynchronous transfer mode (ATM) networks
g. AES50-2011: AES standard for digital audio engineering - High-resolution multi-channel audio interconnection
h. AES54-2-2008 (r2013): AES standard on interconnections - Grounding and EMC practices - Shields of balanced audio wiring within fixed and portable passive connector panels, jack fields, and passive microphone splitters
i. AES54-3-2008 (r2013): AES standard on interconnections - Grounding and EMC practices - Shields of balanced microphone-level outputs of active equipment other than microphones
j. AES67-2015, methods for high-performance streaming audio-over-IP network interoperability.
k. AES70-1-2015: AES standard for audio applications of networks - Open Control Architecture - Part 1: Framework
l. AES70-2-2015: AES standard for audio applications of networks - Open Control Architecture - Part 2: Class structure
m. AES70-3-2015: AES standard for audio applications of networks - Open Control Architecture - Part 3: Protocol for TCP/IP Networks

4. ANSI/ INFOCOMM:
   a. 1M:2009 Audio Coverage Uniformity
   b. 2M:2010 Standard Guide for Audiovisual Systems
   c. 3M-2011 Projected Image System Contrast Ratio
   d. 10:2013 Audiovisual Systems Performance Verification
   e. 01:2016 Display Image Size for 2D Content in Audiovisual Systems
5. ANSI / TIA / EIA:
   a. TIA-222 STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS
   b. TIA-455-78 Revision B, FOTP-78 IEC 60793-1-40 Optical Fibers - Part 1-40: Measurement Methods and Test Procedures – Attenuation
   c. TIA 568-B.1-2000 Telecommunications Standard
   d. TIA-568-C.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS
   e. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
   f. TIA / EIA: 606a Telecommunications Infrastructure Standard
   g. TIA / EIA: 607 Grounding and Bonding Requirements
   h. EIA/CEA: 861 A DTV Profile for Uncompressed High-Speed Digital Interfaces.
   i. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History
   j. EIA 232-D Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Serial Binary Data
   k. EIA RS-310-C Racks, Panel, and Associated Equipment
6. Dante: Audinate Pty. Ltd.

a. Uncompressed, multi-channel, low-latency digital audio over a standard Ethernet network using Layer 3 IP packets

7. HDBaseT: Valens
   a. HDBaseT 1.0 HD and 2K
   b. HDBaseT 2.0 HD 2K and 4K
8. SMPTE / IEEE:
   a. ST 348:2005 - SMPTE Standard - For Television — High Data-Rate Serial Data Transport Interface (HD-SDTI) / 292M – SMPTE SDI
   b. ST 425-3:2014 - SMPTE Standard - Image Format and Ancillary Data Mapping for the Dual Link 3 Gb/s Serial Interface
   c. ST 2081-10:2015 SMPTE Standard - 2160-Line and 1080-Line Source Image and Ancillary Data Mapping for Single-Link 6G-SDI
   d. ST 2082-10:2015 - SMPTE Standard - 2160-line Source Image and Ancillary Data Mapping for 12G-SDI
   e. IEEE 802.1 AVB (Audio Video Bridging)
9. Video Coding Experts Group VCEG
   a. H.262[1] or MPEG-2 Part 2
   b. H.263
   c. H.264/MPEG-4 AVC
   d. H.264 or MPEG-4 Part 10
   e. H.265 or High Efficiency Video Coding (HEVC),
10. AUDIO REFERENCE PUBLICATIONS:
    a. Handbook for Sound Engineers The New Audio Cyclopedia (Howard W. Sams, Indianapolis, Indiana 1987) Davis
    b. Sound System Design and Optimization (Focal Press) Bob McCarthy
    c. Sound System Engineering, Second Edition (Howard W. Sams, Indianapolis, Indiana 1987) Davis
11. VIDEO REFERENCE PUBLICATIONS:
    a. National Association of Broadcasters Engineers Handbook (latest edition)
    b. Digital Video and HD, Second Edition: Charles Poynton
12. FIBER OPTIC REFERENCE PUBLICATIONS
    a. Refer to the fiber optic cable manufacturers design guide: i.e. SIECOR
       1) Siecor Universal Transport System (UTS) Design Guide, Siecor Corp., 1988 Brochure #CC-110
    b. Also refer to the following standards committees:
       1) ANSI: (IEEE) 802.8 Proposed Fiber Distributed Data Interface

1.7 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide Audiovisual System(s) compatible with the Owner's communications systems (i.e. telephone, video, and computer systems) and operations.

B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.

C. The Contractor shall provide complete and operational system(s) configured and installed for user-friendly operation and low maintenance.
   1. Provide for reprogramming of the remote-control software two (2) times, as directed by the Owner's Representative and or Consultant.

2. Provide for two (2) level adjustments of the Audio System(s), as directed by the Owner's Representative and or Consultant.

D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.

E. The Contractor shall restore all finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.

F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.

G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.

H. All finalized software affiliated with the equipment, including but not limited to, the audio DSP, Control System, etc. is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.

I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM(S) DESCRIPTION AND REQUIREMENTS

A. The following is a basic system(s) description and is not intended to be all-inclusive for proper installation or operation of system(s). The AV specification and the AV Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.
   1. The Bid proposal will include all labor and cabling for all optional and/or add alternate equipment listed in specification and AV Bid set drawings. Please list as separate budgetary items.

B. Included Audiovisual Spaces:
   1. General Classrooms
      a. General classrooms have a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
      b. Audio
         1) Provide speakers along with smart display
         2) Audio enhancement system
      c. Video
         1) Provide smart board interactive display with all required accessories
            a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
            b) Mounting height range shall be determined by classroom and student age / median height.
         2) Provide video cables adapters and accessories as required
      d. Control
         1) Control as part of smart board interactive display.
      e. Miscellaneous

1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

2. STEM Labs
   a. Science classrooms have a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
   b. Audio
      1) Provide speakers along with smart display
      2) Audio enhancement system
   c. Video
      1) Provide smart board interactive display with all required accessories
         a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
         b) Mounting height range shall be determined by classroom and student age / median height.
      2) Provide video cables adapters and accessories as required
   d. Control
      1) Control as part of smart board interactive display.
   e. Miscellaneous
      1) Provide ultra-small form factor PC with wall / display mount
      2) Provide all cables and hardware as required
3. Science Labs
   a. Science Labs have a touch enabled smart display with small form factor PC behind display for student use.
   b. Audio
      1) Provide speakers along with smart display
   c. Video
   d. Provide smart board interactive display with all required accessories
      a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
      b) Mounting height range shall be determined by classroom and student age / median height.
      2) Provide video cables adapters and accessories as required
   e. Control
      1) Control as part of smart board interactive display.
   f. Miscellaneous
      1) Provide ultra-small form factor PC with wall / display mount
      2) Provide all cables and hardware as required
4. Multipurpose Art Room
   a. Multipurpose Technology Labs have a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
   b. Audio
      1) Provide speakers along with smart audio enhancement system
   c. Video
      1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
b) Mounting height range shall be determined by classroom and student age / median height.

2) Provide video cables adapters and accessories as required

d. Control

1) Control as part of smart board interactive display.

e. Miscellaneous
1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

5. Collaborative Areas
a. Commons Rooms have a two-touch enabled smart display with small form factor PC behind display for student use. It as well has a ceiling mounted projector and screen with connections for the projector and optional audio enhancement system.
b. Audio
1) Provide speakers along with smart display
c. Video
1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
b) Mounting height range shall be determined by student age / median height.

2) Provide Ceiling mounted digital projector
3) Provide video cables adapters and accessories as required
d. Control
1) Control as part of smart board interactive display.
2) Provide wall mounted control panel for projector
3) Provide wall mounted control for projection screen
e. Miscellaneous
1) Provide ultra-small form factor PC with wall / display mount for each smart board display
2) Provide motorized projection screen (ceiling recessed) per section 27 41 13
3) Provide all cables and hardware as required

6. Resource Rooms
a. Resource rooms have flat panel displays display with internal speakers and wall mounted connections for use with portable devices.
b. Audio
1) Provide speakers along with smart display
c. Video
1) Provide flat panel display with all required accessories

a) Provide fixed wall mount

2) Provide video cables adapters and accessories as required
d. Control

1) Control via manufacturers remote.

e. Miscellaneous

1) Provide all cables and hardware as required

7. Computer Lab
   a. The Computer lab has a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
   b. Audio
      1) Provide speakers along with smart display
      2) Audio enhancement system
   c. Video
      1) Provide smart board interactive display with all required accessories
         a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
         b) Mounting height range shall be determined by classroom and student age / median height.
      2) Provide video cables adapters and accessories as required
   d. Control
      1) Control as part of smart board interactive display.
   e. Miscellaneous
      1) Provide ultra-small form factor PC with wall / display mount
      2) Provide all cables and hardware as required
8. Arts Classroom
   a. The Arts Classroom has a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
   b. Audio
      1) Provide speakers along with smart display
      2) Audio enhancement system
   c. Video
      1) Provide smart board interactive display with all required accessories
         a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
         b) Mounting height range shall be determined by classroom and student age / median height.
      2) Provide video cables adapters and accessories as required
   d. Control
      1) Control as part of smart board interactive display.
   e. Miscellaneous
      1) Provide ultra-small form factor PC with wall / display mount
      2) Provide all cables and hardware as required
9. Media Center/Library
   a. The media center has one touch enabled smart display with small form factor PC behind display for student use.
   b. Audio
      1) Provide speakers along with smart display
   c. Video
      1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
b) Mounting height range shall be determined by classroom and student age / median height.

2) Provide video cables adapters and accessories as required

d. Control

1) Control as part of smart board interactive display.

e. Miscellaneous
1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

10. Dance Classroom
a. The strings classroom has a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
b. Audio
1) Provide speakers along with smart display
2) Portable audio system that will allow the instructor to play back recorded sources or record the audio within the space.
3) The portable equipment rack will have an I/O panel that will allow microphone connectivity.
c. Video
1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
b) Mounting height range shall be determined by classroom and student age / median height.

2) Provide video cables adapters and accessories as required
d. Control
1) Control as part of smart board interactive display.
e. Miscellaneous
1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

11. Choral Classroom
a. The choral classroom has a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
b. Audio
1) Provide speakers along with smart display
2) Portable audio system that will allow the instructor to play back recorded sources or record the audio within the space.
3) The portable equipment rack will have an I/O panel that will allow microphone connectivity.
c. Video
1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"

b) Mounting height range shall be determined by classroom and student age / median height.

2) Provide video cables adapters and accessories as required

d. Control
1) Control as part of smart board interactive display.

e. Miscellaneous
1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

12. Band Classroom
a. The band classroom has a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
b. Audio
1) Provide speakers along with smart display
2) Portable audio system that will allow the instructor to play back recorded sources or record the audio within the space.
3) The portable equipment rack will have an I/O panel that will allow microphone connectivity.
c. Video
1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
b) Mounting height range shall be determined by classroom and student age / median height.

2) Provide video cables adapters and accessories as required
d. Control
1) Control as part of smart board interactive display.
e. Miscellaneous
1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

13. Life Skills Classrooms
a. Life skills classrooms have a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
b. Audio
1) Provide speakers along with smart display
2) Audio enhancement system
c. Video
1) Provide smart board interactive display with all required accessories

a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
b) Mounting height range shall be determined by classroom and student age / median height.

2) Provide video cables adapters and accessories as required
d. Control
1) Control as part of smart board interactive display.
e. Miscellaneous

1) Provide ultra-small form factor PC with wall / display mount
2) Provide all cables and hardware as required

14. Health Room
    a. The health room has a touch enabled smart display with small form factor PC behind display for student use. It as well has connections to the teacher's desk for the display and optional audio enhancement system.
    b. Audio
        1) Provide speakers along with smart display
        2) Audio enhancement system
    c. Video
        1) Provide smart board interactive display with all required accessories
            a) Provide height adjustable wall mount with the ability to move display up and down at least 15"
            b) Mounting height range shall be determined by classroom and student age / median height.
        2) Provide video cables adapters and accessories as required
    d. Control
        1) Control as part of smart board interactive display.
    e. Miscellaneous
        1) Provide ultra-small form factor PC with wall / display mount
        2) Provide all cables and hardware as required
15. Conference Rooms
    a. Large conference rooms have a wall mounted flat panel display with wall connections.
    b. Audio
        1) Provide speakers along with smart display
    c. Video
        1) Provide flat panel display and wall mount
        2) Provide video cables adapters and accessories as required
        3) Provide HDMI and VGA extenders from floor box/ wall box to the flat panel display.
    d. Control
        1) Control via manufacturers remote control
    e. Miscellaneous
        1) Provide all cables and hardware as required
16. Gymnasium
    a. The gymnasium is envisioned to have an equipment rack that is intended to house supporting equipment not required to be accessed by the room user.
    b. Audio
        1) Provide wall mounted microphone inputs
        2) Provide amplifiers and processing
            a) Provide interface / connection to the building paging system allowing building wide pages to be heard within the spaces.
            b) Provide system mute upon fire alarm activation allowing only building wide paging as a source.
        3) Provide wireless microphones with antenna extenders
        4) Provide ceiling mounted speakers
        5) Provide assisted listening system RF type

c. Video
   1) No video in this system
d. Control
   1) Provide wall mounted control panel within each space with protective covers
e. Miscellaneous
   1) Provide wall mounted equipment rack with power distribution and wire management
   2) Provide all cables and hardware as required.

17. Cafetorium
   a. Overview
   b. The Cafetorium is configured as a multi-use performance and presentation venue with audio reinforcement and video projection equipment.
   c. Playback Sources
      1) Provide CD Player/iPod Doc for use on the mixer rolling cart.
      2) Provide Blu Ray Player c for use on the mixer rolling cart.
   d. Audio Equipment
      1) Provide Audio Digital Signal Processor (DSP), rack mounted used for speaker equalization and processing.

         a) Provide programming and mode selection presets within DSP configured per the following:
            I. Auto mixer mode provides operator less use of the audio system via three inputs located one in each of the three floor boxes
            II. Mixer mode: selects the operator mode allowing for the audio mixing console inputs and outputs to be utilized
      2) Provide Power Amplifier(s) rack mounted, selection based on speaker continuous power rating and configuration(s).
      3) Provide ADA/Assistive Listening System (ALS), rack mounted transmitter, antenna and receivers. Include both ear bud and inductive loop options for receiver packs.
      4) Provide line array program speakers and sub woofers intended to provide even coverage and maximized aural intelligibility within the audience seating area.
      5) Provide wall mounted fixed stage fill speakers mounted above the proscenium opening within the rigging and lighting area.
      6) Provide ceiling mounted pendant speakers mounted within the seating area.
      7) Provide four (4) hanging stage microphones.
      8) Provide microphone, and intercom connectivity locations as detailed within the audiovisual drawing package.
      9) Provide digital mixing console located on mixer rolling cart. Provide patchable connections to allow for the mixing console surface to be located either on the stage or at the rear of the seating area and connect to the stage box.
      10) Provide rack mounted digital mixing console expansion frames / stage boxes.
      11) Provide wired intercom, four channel unit. Two channels shall be assigned to the Black Box Theater two to the Cafetorium. Provide cables, belt packs and head sets.
      12) Provide wireless microphone combo units with rack mounted receiver.
      13) Provide Wireless microphone antenna, rack mounted distribution, cabling and antenna amplifier.

e. Video Equipment
   1) Provide WUXGA Laser light source projector (VP1) with ceiling mounting hardware. Projector is located in the ceiling of the Cafetorium. Projector location shall be coordinated with all ceiling elements to include lighting placement.

      a) Reference specification section 274113 for projection screen information
      b) Contractor shall coordinate projector location and lens selection with screen location and throw distance reducing the need for lens shift and or keystone adjustments from improper placement
   2) Provide multi format input extenders
   3) Provide HDMI receiver at projector location.
   4) Provide digital video matrix switch, rack mounted, this matrix to be shared between the Black Box Theater and the Cafetorium systems.

f. Control equipment
   1) Provide audiovisual control system with touch panel control.
   2) Provide an easy to use graphical user interface (GUI) for touch panels.
   3) Provide the following control functions:

      a) Projector on / off
      b) Video source selection
      c) Video mute
      d) Auto mode / Mixer mode selections with DSP presets configured for both modes of operation.
      e) (Auto mode) volume up/down/ mute
      f) (Mixer mode) control via mixer only
      g) Screen control up/down
   4) Provide sequential power on and off capabilities for audiovisual system via a single on / off panel interface.

g. Miscellaneous Equipment
   1) Provide Equipment Rack(s) (JB1) located in the stage left equipment room. This enclosure has supporting equipment for both the Black Box Theater and the Cafetorium.
   2) Provide UPS Power Conditioner for each rack provided.
   3) Provide Surge Suppressor (Power Dist.) with sequential power on / off configuration for each rack provided.

18. Provide all adapters, plates, panels and cables as required for a complete and

1.9 RELATED WORK

A. Conduits:
   1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
   2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.

B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

C. The Contractor shall, without cost to the Owner and/or Consultant, replace any products damaged during storage, handling or during installation.

1.11 SCHEDULING

A. The Contractor shall submit a schedule to the Owner and/or Consultant for approval within 10 (ten) working days from notice to proceed. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off. This schedule shall be submitted in Microsoft Project (or similar program) in both paper and electronic format, with submittals.

B. It is the responsibility of the Contractor to coordinate the installation of the system(s) to be compatible with the work of the other trades. The Contractor shall attend progress meetings and provide continuous on-site project management.

C. It is the responsibility of the Contractor to arrange with the Owner and/or Consultant a mutually acceptable time and date(s) for Acceptance Testing, based upon project dates and schedule provided, based upon the dates provided in the Solicitation.

D. The Contractor shall provide operating personnel with extensive training for each system type and/or room type as outlined in Section 1.5 SYSTEM(S) DESCRIPTION AND REQUIREMENTS.

1.12 PROJECT SCHEDULE

A. A (mandatory) pre-bid site visit on, DATE at TIME will be utilized to allow the Contractor to review the current jobsite conditions and define special requirements.

B. All Requests for Information (RFI) shall be directed to the Consultant and should be received by Close of Business (COB) on DATE.

C. All bids must be received at the Warrenton office of Polysonics to the attention of the Consultant. All bid proposals (electronic copy) are due to Polysonics no later than TIME on DATE.

D. Hard copies of the bid proposals will be accepted by COB on TBD.

E. Please submit three hard copies.

F. The opening of the bid proposals will be held between Polysonics and the Owner's Representative, with no bidder's present.

1.13 BID TECHNICAL PROPOSALS

A. The Contractor shall be experienced in the provision of systems similar in complexity to those required for this project and Contractor shall provide documentation demonstrating the below minimum criteria:
   1. The primary business of the Contractor and/or Installer shall be the installation of audio or video systems.
   2. At least three (3) years' experience with the specified equipment and systems.
   3. Experience with at least one project of similar size and complexity as outline in these specifications.

4. Be an authorized dealer and service facility for the products specified and furnished.
5. Maintain a technically trained installation crew and service crew for maintenance and installation of the specified system(s).
6. Lead Installer shall have attended factory training in DSP and digital format for equipment specified in this specification.
7. Contractor shall demonstrate that the installation staff consists of 50% CTS-I trained personnel and have at least one (1) CTS-D on staff.
8. Final Audiovisual System(s) configurations shall be approved by the Owner's Representative, Architect and Consultant.
9. Upon request of the Owner and/or Consultant, Contractor shall demonstrate that he has:
   a. Sufficient facilities and equipment for this work.
   b. Sufficient staff with the appropriate technical expertise and experience for this project.
10. All Bid proposals shall be valid for ninety (90) days from date received.
11. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected and/or declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment.

B. Provide a list of five (5) references with locations, names of contacts, and contact phone and email information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old and be of similar size, type, and complexity as the system set forth.

C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents and drawings, manufacturer requirements, and RFI responses as applicable.

1.14 PRE-BUILD AND FINAL SUBMITTALS

A. Provide the following for approval no later than thirty (30) days after Notice to Proceed and prior to commencement of work:
   1. A complete list of all products incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
   2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
   3. All shop drawings defined as required.
   4. Suspended loudspeaker rigging design and/or details with a Professional Engineer's certification as described in section 3.05.
   5. Contractor shall supply to Consultant and/or owners' representative, all DSP and control graphical user interface layouts for review and comment and approval. Contractor shall provide any necessary adjustments to software as deemed by the Consultant and or Owner's Representative.

B. Shop Drawings:
   1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of system(s).
   2. Shall be scaled appropriately but not less than 1/8" =1'.

3. Shall show detailed schematic wiring diagrams showing interconnection of Contractor-provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
4. Shall show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling.
5. Shall show all A.C. power outlet locations and terminal strip locations within each equipment rack including all sequencing as required for proper start-up and shut down.
6. Shall show plans and sections of the building and adjacent grounds with the location of all installed equipment such as loudspeakers, racks, consoles, plates and/or panels, antennas, (etc.).
7. Shall show patch panel layouts and labeling strips, including color schemes, as necessary.
8. Shall show full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
9. Shall show all speaker mounting details including hardware types and load capacity. Structural information with design calculations and a copy of the PE's certifications for each item and/or drawing.
10. Shall provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate and sample plates per type.
11. Shall show complete labeling schemes for all cabling and equipment components for project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
12. Shall show a complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout coordination information.

C. Submittal Format: (PDF version)
1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
2. Separate major groupings Use multiple volumes and/or list of content
3. Index product data sheets by manufacturer and model or part number.
4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
5. Reference addendum or change order numbers as applicable.
6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
7. Provide via pdf, posted to FTP, thumb drive and or CD / DVD ROM.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

D. Submittal Format: (Printed Option if Required)
1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
6. Reference addendum or change order numbers as applicable.

7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

1.15 PROJECT CONDITIONS

A. Verify conditions on the job site applicable to this work. Notify Owner's Representative and/or Consultant in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.16 QUALITY ASSURANCE

A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.

B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating audiovisual equipment and services. Manufacture shall be able to similar installations rendering satisfactory service.

C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.
   1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.
   2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
   3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.17 PRE-INSTALLATION MEETING SCHEDULE

A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.

B. A Conduit/Wiring Analysis shall be conducted at the Pre-Installation Meeting. The Contractor shall submit "as-built" drawings locating all existing conduit runs, junction boxes, and electrical outlets. Show location and type of all special receptacle boxes and plates to be supplied and/or modified by the Contractor. Verify and inspect all necessary conduits and outlets. Provide with the submittals, a list of all conduits, boxes, and power changes necessary for installation of systems in each location.

1.18 FINAL INSPECTION AND TESTING AND/OR COMMISSIONING

A. Upon completion of installation and Contractor testing and commissioning (as outlined in sections 3.7-), the Consultant shall perform system(s) inspection and testing (as outlined in section.

B. To assist the Consultant, the Contractor shall provide a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the specified system(s).

C. The process of testing the system(s) may necessitate moving and/or adjusting certain components such as speaker aiming, transformer tap values, software adjustments, DSP adjustments.

D. Testing will include operation of each system and all components. The Contractor will provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.

E. In the event, that adjustments or work is required during testing, or to bring the systems into specification, the Contractor shall continue his work until the system(s) are acceptable with no addition to the contract price. If approval is delayed due to defective equipment, and/or failure of equipment or installation that meets the requirements of this specification, the Contractor shall pay for additional time and expenses to the Owner at the rate specified by the Owner.

F. All Control Systems shall be fully tested prior to commissioning. Once the Control Programming is finalized all source code, programming, and touch panel software shall be burned on to a CD ROM or thumb drive and delivered to the Owner. All Control System programming (including source, files, touch panel design), and DSP files shall become the property of the Owner.

G. The Digital Audio Console shall be fully programmed and tested prior to commissioning. Once the programming is "finalized" and accepted all presets and console configuration shall be stored on a USB drive and burned onto a CD ROM and delivered to the Owner. All active console input and outputs should be labeled for ease of operation and clarity.

1.19 WARRANTY

A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial two-year service contract.

B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.

C. The Contractor shall respond with a remedy to a trouble call within twenty-four (24) hours upon receipt of such a call and shall provide a 24-hour service phone number. Downtime for system(s) shall be no longer than a 24-hour period. All replacement parts and/or components shall be of equal or higher level of service.

D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

E. At least two routine inspections and adjustment visits shall be scheduled for the first year, coordinated with Owner's Representative.

F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.

G. The Contractor shall be present at the first use of the system (scheduled by the Owner), and one (1) additional event as requested by the Owner for no additional charge.

1.20 INSTRUCTION OF OWNER PERSONNEL

A. After final inspection and completion, provide instruction to Owner-designated personnel on the operation and maintenance of the system(s).

B. A training program shall be designed to provide a comprehensive understanding and basic level of competence with the system. It shall be sufficiently detailed to allow Owner personnel to operate the system independent of any outside help.

C. The training plan or class shall include detailed sections outlines and related reference materials. The Owner personnel shall be able to utilize these materials in the subsequent training of their co-workers.

D. Submit an outline of the course with sample instructional aids for approval one (1) week prior to scheduled instruction sessions.

E. The training time shall not be less than a total of 32 hours, and shall consist of:
   1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
   2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
   3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's telecommunications personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electronic component models shall be commercially available for a least one (1) year prior to bid or be approved by the Consultant and or Owner's Representative.

B. All equipment and material shall be new unless otherwise noted in this specification.

C. All equipment must be UL listed or built to UL standards, where required.

2.2 GENERAL

A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied, unless a variance (exemption document) is submitted and approved by the Consultant.

B. System(s) shall be installed and configured for simplicity of operation, with user-friendly controls.

C. Provide product quantity as required for complete and operable system(s). If any quantities are given, the Contractor shall provide at least the given amount. Some of the products listed under this section may not be required to fulfill the work as outlined.

D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.

E. Remove all manufacturer's nameplates or logos from product, such as found on speaker(s), within the public sight lines or spaces when applicable.

F. Paint all wall and ceiling mounted speaker grilles and enclosures as directed by the Consultant and/or Architect.

G. The Contractor is responsible for providing a fully operational turnkey audiovisual system. The following equipment list and attached drawings are for final design intent purposes.

H. The Contractor shall program no less than five (5) presets on the audio console such that the first preset will reset the console to a default "cleared" setup and each of the other presets will be for various levels of user group activities. Additionally, settings that are not needed for everyday use will be locked out and the password will be given to Owner. Additionally, no less than three (3) user groups will be programmed and password protected.

2.3 AUDIO SYSTEMS

A. Digital signal processor (DSP / Audio Mixer) DSP Type 1
   1. 12 mic/line AEC inputs
   2. 8 mic/line output s
   3. Up to 8 configurable USB I/O channels
   4. Expandable to 128x128 channels via AVB network
   5. Configured for videoconference support with no internal phone hybrid
   6. Rack mountable
   7. Acceptable Product:
      a. Biamp TesiraFORTE AVB AI or approved equal

B. Paging Processor
   1. 8 Admin Phone / Telephone Slots
   2. 256 Ports (2048 networked) *
   3. 64 Page Zones
   4. 1 or 2 Intercom Channels
   5. Network Install (up to 8 systems) *
   6. AssistantTM / CalendarTM Software
      a. Care Hawk CH1000, or approved equal

C. Power Amplifier
   1. Four channels with bridgeable channels
   2. Signal, clip, and protect LED
   3. Low Z & 70V/100V
   4. Screw terminal output connectors
   5. Nomad Link network ready
   6. Acceptable Product:
      a. Type 1 1700 watts over 4 channels at 70v – Lab Gruppen C68.4 or approved equal
      b. Type 2 1200 watts over 4 channels at 70v – Lab Gruppen C4 or approved equal
      c. Type 3 1200 watt over four channels at 70v- Lab Gruppen C48.4 (Gym) or approved equal.
      d. Type 4 1200 watt over two channels at 70v E12:2 (Gym) or approved equal.

D. Classroom Audio System
   1. Null, duplex audio
   2. Simple user interface software

3. Intercom and paging functionality built-in
4. Redundant power source during power outages
5. Compatible with SAFE Commander or other SIP-based bell or public announcement systems
6. MS-450 Networked Amplifier: Line Inputs: For PC, DVD audio, MP3, auxiliary mic, or other multimedia sources; 1 Line balanced/unbalanced input (Euroblock); 3 Line unbalanced stereo inputs (3.5 mm); 1 Input connector for IR- Satellite; Internal Network Audio; Line Outputs: 2 Unbalanced Line Outputs (RJ45 Connectors);
7. Continuous Power @ 1% THD : 32 Watts (16 Watts (rms) per channel x 2 channels @ 4 ohms), backup amp powered by PoE
8. RS-232, 3-pin screw terminal block header, RJ45 remote control port
9. (2) RS-232 communication ports: (1) to control the MS-450, and (2) to control another classroom device such as a projector
10. (2) Remote Control Ports: for integration with wall plate controls
11. Power Input (Network): PoE 802.3at or 802.3af for IP interface
12. CS-12 Ceiling Speakers: Frequency range of 70 Hz to 15 kHz (-10dB); Tuned ported enclosure provides superior bass response; Integral C-clamp mounting
13. XD Teacher Microphone: Auxiliary line level input connector allows for playback of any device using a standard 3.5 mm jack; Can be used either with built-in clip or included lanyard; Rechargeable Lithium-Ion Battery
14. XD Receiver: Adjustable for optimal coverage from small classrooms to cafes, gyms, and other large spaces; Remote control via Teacher Microphone of both microphones and auxiliary levels; Line level 3.5 stereo mini jack (monaural mix), RJ45 line level output, line level 3.5 mm stereo output; Feedback blocker on both microphone channels
15. Acceptable product:
    a. Audio Enhancement Optimum Classroom MS 450-XD System-4 Ceiling Speakers (KIT) 10000-1200

E. Paging Interface Module
1. Rugged gooseneck and all-metal body
2. Audio frequency bandwidth: 150Hz to 15kHz
3. Sensitivity: 2.2 mV/Pa
4. Electrical impedance: 530 Ohms
5. Recommended load impedance: 2000 Ohms
6. Polar Pattern: cardioid
7. Audio output: Type - Balanced XLR, Gender - Male, Contacts - 3-pin
8. Acceptable product:
    a. Audio Enhancement MS 250 3000-0464

F. Ceiling Loudspeakers at (SP)
1. Average Sensitivity – 92 dB SPL, 1W/ 1M
2. Loudspeaker Power Rating – 20W RMS, EIA 426A Standard
3. Calculated Output – 104 dB SPL, 5W/ 1M
4. Magnet Type & Weight – BeFe Ceramic, 10 oz. Nominal
5. Frequency Response – 60Hz - 17kHz EIA 426A Standard
6. Nominal Coverage Angle – 90° Included Angle, -6 dB / 2 kHz, Half space
7. Audio Connection – 7" Color-Coded Pigtails, Pre-Cut
8. Electrical Access – 1/2" Side Mounted, Flexible Conduit Clamp
9. Acceptable product:
    a. Quam System 21, or approved equal

G. Ceiling Speakers at (SP2)
   1. Consistent 90° x 90° broadband pattern control
   2. 300 mm (12 in) woofer with Kevlar-reinforced cone and 75 mm (3 in) voice coil.
   3. 25 mm (1 in) exit compression driver with unique patented design and high temperature polymer diaphragm.
   4. Overload protection
   5. 55 Hz – 20 kHz frequency response.
   6. 200-Watt 70V/100V multi-tap (built-in transformer)
   7. Acceptable product:
      a. JBL AWC129, or approved equal

H. Wall Mounted Speaker (SP6)
   1. 8" woofer with woven fiberglass cone
   2. 1" PEI diaphragm tweeter with fluid cooling
   3. Contemporary, high-design appearance
   4. Built-in InvisiBall mounting hardware
   5. Weather resistant enclosure and transducers
   6. Wide 100° x 100° coverage
   7. 120-Watt power handling (240-Watt program)
   8. High fidelity sound character with broad frequency response of 45 Hz - 20 kHz
   9. Acceptable product:
      a. JBL Control 28-1L (white)

I. Gym Speaker (SP1)
   1. Consistent 90° x 90° broadband pattern control
   2. 300 mm (12 in) woofer with Kevlar-reinforced cone and 75 mm (3 in) voice coil.
   3. 25 mm (1 in) exit compression driver with unique patented design and high temperature polymer diaphragm.
   4. Overload protection
   5. 55 Hz – 20 kHz frequency response.
   6. 200-Watt 70V/100V multi-tap (built-in transformer)
   7. Acceptable product:
      a. JBL AWC129 (white)

J. Wireless Microphone System
   1. Selectable frequencies / Auto Transmitter setup digital transmission design.
   2. XLR and ¼" outputs
   3. Mic/line switchable
   4. Detachable ¼ wave antennas, receivers compatible with antenna distribution and remote antenna configurations.
   5. Rack mountable
   6. QLXD2/SM58 handheld transmitter, with Beta 58 microphone capsule
   7. WL185 lavalier microphone with QLXD1 bodypack transmitter,
   8. QLXD4 standard diversity receiver
   9. Acceptable product:
      a. Shure QLX-D 124/85, or approved equal

K. RF Distro
   1. Wideband UHF
   2. Four-Way Active Antenna Splitter and Power Distribution System
   3. Provide with antennas and boosters or amplifiers
   4. Acceptable product:

a. Shure UA844SWB, Shure UA830USTV, Shure UA860WB, Shure UA8100, or approved equal

L. ADA/Assistive Listening System
1. Truly Wireless – Roam up to 150 feet (46 m) from the antenna with complete freedom
2. Superior Audio Quality – 80 dB signal to noise ratio
3. Compatible with most assistive listening equipment
4. Provide with transmitter
5. Provide with extended antenna (RF2)
6. Provide with receiver
7. Provide rechargeable batteries (Quantity of 6)
8. Provide ear speakers (Quantity of 6)
9. Provide Stereo headphones (Quantity of 6)
10. Provide Case/charger to support the charging of 6 receivers
11. Provide neck loops (Quantity of 6)
12. Acceptable Product:
    a. Listen technologies LT-800-072-P1, and Listen technologies LP-40-072

M. Stage Box
1. 16 MIDAS-designed, fully programmable mic preamps for audiophile sound quality
2. 8 analog, servo-balanced XLR outputs
3. 32 bidirectional audio channels over Cat 5e cable (48 kHz)
4. Single cable duplex interconnection for audio and sample clocks
5. Acceptable product:
    a. Behringer S16

N. Mixing Console (FOH)
1. 25 motorized faders
2. 40 Input, 25-Bus Digital Mixing console
3. 32 Programmable XLR MIDAS Preamps
4. 8 Auxiliary Channels
5. 8 Effects return Channels
6. A/D-D/A conversion, 24-bit @44.1 / 48 kHz, 114 dB dynamic range
7. Networked I/O Latency 1.1 ms
8. Internal programmable and patchable effects to include the following: Delays. Limiters, Reverb, Plate Reverb, Reverse reverb, Equalizers, Compressors
9. Acceptable product:
    a. Behringer X32

O. Line Array Speaker (SP3) Center
1. Coverage pattern 100 x 15 degrees nominal
2. 12" LF driver
3. 1.5" Compression drivers
4. Passive internal crossover selection
5. Sensitivity 95 dB SPL, 1w@1m
6. Frequency Response 75 Hz – 20 kHz ±3 dB
7. 800 W continuous Power Rating.
8. Provide with all necessary mounting and flying hardware
9. Acceptable product:
    a. JBL VRX932LA, JBL VRX-AF

P. Line Array Subwoofer (SP3) Sub Center

1. 18" LF driver
2. Sensitivity 95 dB SPL, 1w@1m
3. Frequency Response 34 Hz – 220 Hz ±3 dB
4. 800 W continuous Power Rating
5. Provide with all necessary mounting and flying hardware
6. Acceptable product:
    a. JBL VRX918S, JBL VRX-AF

Q. Side Fill Speaker (SP3) Left and Right
1. 90 x 90-degree waveguide with 25mm (1") dome tweeter
2. 135mm (5.25") LF transducer
3. Ultra-Compact 2-way Loudspeaker with 2 x 5.25" LF
4. 450W Program
5. Dual Neutrik NL4 connectors plus screw terminal
6. Attachment points for optional U-bracket
7. Frequency Range (-10dB): 80Hz - 20kHz
8. Frequency Response: 90Hz - 18kHz
9. Power Rating: 225W Cont Pink Noise, 450W Program, 900W Peak
10. Impedance: 16 ohms
11. Coverage Pattern: 90 degrees x 90 degrees
12. Dimensions: 14.9" x 5.9" x 7"
13. Weight: 16.5 lbs
14. Include all mounting equipment hand hardware
15. Acceptable product:
    a. JBL AC25 (White)

R. Stage Fill Speakers
1. Coverage pattern 120 x 110 degrees nominal
2. 10" LF driver
3. 5" MF driver
4. 1" HF driver
5. Sensitivity 93 dB SPL, 1w@1m
6. Frequency Response 40 Hz – 16 kHz ±3 dB
7. 500 W continuous Power Rating
8. Provide with InvisiBall wall mount hardware
9. Acceptable product:
    a. JBL Control 30 (white)

S. Pendent Speaker (S2)
1. Compact Design
2. 5.25" Woofer with Silk-Dome Tweeter
3. Radiation Boundary Integrator Technology
4. 120° Conical Coverage
5. 75W Power Handling
6. 60W Multi-Tap Transformer
7. Full Grille
8. Include all mounting and hardware
9. Acceptable product:
    a. JBL Control C65 P/T (white)

T. Microphone Splitter
1. Operating Level: -0.5dB to +4dB

2. Frequency Response: 20Hz-20kHz ± 0.63dB
3. Max input level: -0.5 dBu
4. Acceptable product:
    a. Whirlwind SP1x2

U. Hanging Microphone
1. Response optimized for consistent sound quality.
2. Unobtrusive slimline design.
3. Superior grade components.
4. Engineered in high quality brass.
5. Semi-Rigid Gooseneck shaft.
6. Included PPA-RF or CPPW01-RF.
7. Finish: White.
8. Acceptable product:
    a. Clock Audio C 3SE-RF

V. Wired Microphones
1. Acceptable product:
    a. Hand Held Cardioid Microphone – Shure SM58 (Qty:4) with (8) Atlas T3664 stands, (8) Atlas PB-21XE Boom arms, (8) Whirlwind MKQ10, (8) Whirlwind MKQ20, and (8) Whirlwind MKQ50.

W. CD/MP3/iPod Player (Performance Classrooms, Gym)
1. Plays audio CDs, MP3 CDs, and WAV file CDs.
2. Dock connector for Apple iPod charging and playback.
3. iPod video playback from S-video and composite output.
4. CD TEXT and ID3 tag support.
5. Continue, Random, and Program play modes.
6. Repeat All and Repeat Single play modes.
7. Shock/skip prevention memory buffer.
8. +/- 12% pitch control (analog outputs only).
9. RCA unbalanced line outputs (CD and iPod).
10. ¼" Stereo headphone output.
11. Acceptable product:
    a. Tascam CD-200iL

X. Audio Network Recorder/Player (Performance Classrooms)
1. Plays digital music from computers, music servers, and online services with your home stereo system
2. Cirrus Logic CS4398 DAC (digital-to-analog converter) for high-performance playback of digital music
3. Built-in Wi-Fi for easy connection to a wireless home network
4. Bluetooth wireless connectivity for streaming music from compatible smartphones, tablets, and computers
5. Dual-diversity antennas and dual-band "N" technology ensure solid, stable Bluetooth and Wi-Fi streaming
6. Apple AirPlay for streaming music from an iPhone, iPod touch, iPad or iTunes on your computer
7. DLNA 1.5 certified for streaming music wirelessly from compatible computers and network-attached storage (NAS) drives
8. Includes support for Pandora, vTuner Internet radio, and SiriusXM (subscription required for SiriusXM)

9. Spotify Connect lets you play Spotify's streaming music library via Wi-Fi, controlled by your smartphone or tablet (requires Spotify app and a premium subscription)
10. High-resolution playback of DSD, FLAC, WAV, AIFF, and ALAC files; also plays MP3, WMA, and AAC files
11. Up to 24-bit/192kHz resolution for PCM files; up to 5.6MHz resolution for DSD files
12. front-panel USB input for connecting an iPod, iPhone, or thumb drive
13. Direct digital connection for iPod or iPhone bypasses the device's digital-to-analog converter for better sound
14. Output stage uses Marantz's latest generation Hyper Dynamic Amplifier Modules (HDAM) for low noise and lifelike sound
15. Gapless playback with FLAC, ALAC, WAV, AIFF, and DSD files
16. AM/FM radio tuner
17. Stereo analog RCA outputs
18. Optical digital audio input
19. Optical digital audio output
20. Ethernet port
21. Front-panel USB input (Type A) for connecting an iPod or compatible USB memory device
22. Discrete headphone amplifier with 1/4" output and volume control
23. IR flasher input for use with external controllers
24. Detachable power cordP.
25. Acceptable product:
    a. Marantz NA6005

Y. CD Recorder (Performance Classrooms)
1. A professional-grade CD recorder with a new transport designed and manufactured by TEAC for years of reliability in the most demanding installations
2. The AK4528VM AD/DA chipset manufactured by Asahi Kasei Electronics is employed for finer AD/DA conversion for crystal clear sound quality
3. A rich playback function and a high level of audio performance enable the CD-RW900MKII to be used as a professional-grade CD player
4. The high-performance AKM codec captures audio with a wide dynamic range for better-sounding CD recording
5. A variety of track division functions make recording simpler, and a rec-mute function can insert silence between tracks
6. Improved firmware allows the transport to write track markers without a gap, for seamless continuous live recordings
7. A RAM buffer stores audio data in memory to ensure smooth playback, even if shock or vibration lasts for up to four seconds
8. Acceptable product:
    a. Tascam CD RW900MKII

Z. 8 channel Mixer (Performance Classrooms)
1. 8-Input Mixer
2. Supports USB Drives and Bluetooth
3. 120W, 2-Output Amplifier
4. Euroblock, RCA, and 1/4" Inputs
5. Euroblock Outputs
6. Per-Channel Bass and Treble Controls
7. Voice-Activated Ducking
8. Front-Panel Display and Controls
9. Configurable Output Routing

10. Includes Rackmount Kit
11. Acceptable product:
    a. Marantz NA6005

2.4 VIDEO SYSTEMS

A. 65" Flat Panel Display (Conference Rooms, Collaborative Area's, Resource Rooms, Student Support, Library Commons)
1. 65" Class
2. SE3D Series LED display
3. Digital signage
4. 1080p (Full HD) 1920 x 1080
5. Edge-lit
6. Connector Type: 15 pin HD D-Sub (HD-15)
7. Type: VGA input; Connector Type: 19 pin HDMI Type A; Qty: 2
8. Type: HDMI input;
9. Connector Type: 24+1 pin digital DVI; Type: DVI-D input
10. Connector Type: 4 pin USB Type A; Type: USB 2.0
11. Connector Type: RJ-45; Type: Network
12. Type: Audio line-in
13. Type: Audio line-out
14. Type: Infrared input
15. Type: Serial input
16. Type: Serial output
17. Acceptable product:
    a. LG 65SE3D-B with Chief LSA1U

B. Smart Board Interactive Display – (Classrooms)
1. 75" LED display
2. Optimal resolution 3840×2160 at 60Hz
3. Brightness (maximum) 360cd/m²
4. Touch sensitive display surface
5. 10W integrated speakers (×2)
6. Included cables and accessories, iQ appliance, USB cable, Pen (×4), Eraser
7. Provide with height adjusting wall mount
8. Provide with surge suppression
9. Acceptable product:
    a. Smart Technologies SBID-7275, Chief LSD1U wall mount or Chief LSA1U, Surge-X SA82 or approved equal

C. Laser Projector-10,000 lumen (VP1)
1. SOLID SHINE Laser and DLP™ Projection Balances Image Quality with 20,000-hour Maintenance-free*1 Endurance
2. Dynamic Contrast Function for High Contrast
3. Dust-Resistant Airtight Optical Block
4. Detail Clarity Processor 3 Sharpens the Finest Details
5. Selectable Operational Modes Maintain Image Quality Longer
6. System Daylight View 3 for Sharp and Vivid Images in Bright Environments
7. Stable 24/7 Operation with Light-source Failover Protection
8. Unique Contrast Sync and Shutter Sync Function

9. Geometric Adjustment for Custom Screen Surfaces
10. Geometry Manager Pro Software
11. Multi-Screen Support System Seamlessly Connects Multiple Screens
12. Multi-Unit Brightness and Color Control
13. Single-Cable DIGITAL LINK Control and Video Connection
14. Free 360-degree Rotation
15. Supports Art-Net DMX, Crestron Connected™, and PJLink™
16. Quick Start and Quick Off
17. Panel size: 17.0 mm (0.67 in) diagonal (16:10 aspect ratio)
18. Display method: DLP™ chip × 1, DLP™ system
19. Pixels: 2,304,000 (1920 × 1200) × 1, total of 1,024,000 pixels
20. Laser Diode Laser class 1 (Class3R for US models)
21. Luminance life for set: 20,000 hours at half luminance (normal)/24,000 hours at half luminance (Eco)
22. NOTES *Temperature: 30°C / 86°F, Altitude 700m (2,297 ft), Dust: 0.15mg/m3
23. Dynamic Contrast3
24. 43,800 hours at constant luminance (LONG LIFE1)
25. 61,320 hours at constant luminance (LONG LIFE2)
26. 87,600 hours at constant luminance (LONGLIFE3)
27. 0,000 lumens (Center)*2/ 9,400 lumens*3
28. 9,400 lumens (Half luminance) (NORMAL)
29. 7,500 lumens (Half luminance) (ECO)
30. 3,700 lumens (Constant luminance) (LONG LIFE1)
31. 3,100 lumens (Constant luminance) (LONG LIFE2)
32. 2,500 lumens (Constant luminance) (LONGLIFE3)
33. Center-to-corner uniformity*3: 90%
34. Contrast*3: 10,000:1 (All White/All Black) (Dynamic Contrast3)
35. Resolution: 1920 × 1200 pixels
36. Acceptable product:
    a. Panasonic PT- RZ970WU (av contractor to confirm lens and throwing distance, Chief VCMUW

D. Blu Ray/CD Player
1. Universal Blu-ray disc player that also supports Super Audio CD and DVD-Audio formats
2. 3D Ready (*1, *2, *3)
3. Network functions, to bring you a wealth of online content
4. Enjoy YouTube (*2) and Netflix video distribution services without a PC.
5. Enjoy music, photo, and video files stored on a network-connected device such as a multi-media PC.
6. Supports HDMI 1.4a with 3D ready, Deep Color, "x.v. Color", High-Bit-Rate Audio output and HDMI CEC (consumer electronics control) functions
7. USB port on the front panel
8. Quick play
9. 3RU Rackkit Included
10. Acceptable product:
    a. Denon DBP 1611UDP

E. Digital Matric Switcher

1. All-in-one 8x4 4K matrix switcher, scaler, audio DSP with AEC, audio power amplifier, and control processor
2. Inputs: Six HDMI, two DTP® twisted p air inputs on RJ-45, six stereo balanced/unbalanced audio inputs on captive screw, four mic/line audio inputs on captive screw
3. Outputs: Two HDMI; two DTP twisted pair outputs on RJ-45; one S/PDIF digital audio output on coaxial RCA; four variable audio outputs on captive screw; speaker outputs on 5 mm, 4-pole captive screw connector - DTP CrossPoint® 84 4K IPCP SA or on 5 mm, 2-pole captive screw connector - DTP CrossPoint 84 4K IPCP MA 70
4. Two DTP inputs and six HDMI inputs
5. Two HDMI outputs and two independently scaled DTP outputs
6. Two DTP outputs feature mirrored HDMI connections to support local monitoring
7. 4K matrix switching and scaling with selectable seamless transitions and logo keying
8. Integrated DTP inputs and outputs support transmission of video, control, and audio up to 330 feet (100 meters) over a shielded CATx cable
9. Advanced Extron Vector™ 4K scaling engine
10. Selectable scaled DTP output rates from 640x480 to 4K
11. Compatible with DTP 230 Series and DTP 330 Series, plus XTP® CrossPoint matrix switchers
12. DTP outputs are compatible with HDBaseT-enabled displays
13. Extron XTP DTP 24 shielded twisted pair cable is strongly recommended for optimal performance
14. Compatible with CATx shielded twisted pair cable
15. Remote powering of select DTP transmitters and receivers
16. RS-232 insertion from the Ethernet control ports
17. Bidirectional RS-232 and IR insertion for AV device control
18. Available with integrated IPCP Pro control processor
19. Supports TouchLink® Pro touch panels and eBUS® button panels
20. Integrated three-port AV LAN switch allows AV devices to be isolated from the corporate network
21. AV LAN only permits communications from the Ethernet port for remote management and firmware updates to Extron devices
22. Supports secure industry standard communications protocols
23. Supports LinkLicense®
24. Two bidirectional RS-232 ports with software handshaking
25. One bidirectional RS-232/RS-422/RS-485 port with hardware and software handshaking
26. Two IR/Serial ports for one-way control of external devices
27. Four Digital I/O ports
28. Four relays for controlling room functions
29. eBUS port for connecting eBUS button panels and accessories
30. Ethernet monitoring and control on each Ethernet port
31. DHCP server for AV LAN
32. Supports 10/100/1000Base-T
33. Supports Ethernet-controllable devices
34. Automatic clock synchronization allows touch panel to display the accurate time and date
35. Supports control system synchronization
36. Front panel port status indicators
37. Multi-level password protection
38. Fully customizable using Extron control system software
39. Create controller groups

40. Library of enhanced Extron Certified device drivers
41. HDMI audio embedding
42. HDMI audio de-embedding
43. Output volume control
44. Audio input gain and attenuation
45. Audio breakaway
46. S/PDIF audio output
47. Four mic/line inputs with 48-volt phantom power
48. Integrated audio digital signal processor with ProDSP™ 32/64-bit floating point signal processing
49. Four channels of AEC
50. Auto mixer with eight groups
51. Digital audio expansion port provides interfacing to an Extron DMP 128 Plus processor for audio system scalability
52. Mic ducking
53. Studio grade 24-bit/48 kHz analog-to-digital and digital-to-analog converters Low latency DSP processing
54. DSP Configurator™ Software
55. Group masters
56. Soft limits provide optimal group master adjustment range
57. 32 DSP Configurator presets
58. Supported HDMI specification features include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats
59. User-selectable HDCP authorization
60. Acceptable product:
    a. Extron DTP CrossPoint 84 4K

F. Multi Format Switcher/Transmitter
1. Transmits DisplayPort, HDMI, or VGA plus control and analog audio up to 230 feet (70 meters) over a shielded CATx cable
2. Inputs: One DisplayPort, one HDMI, and one VGA on 15-pin HD, one 3.5 mm stereo mini jack for audio
3. Output: One DTP® 230 twisted pair output on RJ-45
4. Auto-switching between inputs
5. Supports computer and video resolutions up to 4K
6. Analog stereo audio embedding
7. Remote powering of DTP receiver
8. Extron XTP DTP 24 shielded twisted pair cable is strongly recommended for optimal performance
9. Compatible with CATx shielded twisted pair cable
10. Accepts additional analog stereo audio signals
11. Audio input assignment
12. Supports DisplayPort SST
13. Supported HDMI specification features include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats
14. DTP output is compatible with HDBaseT-enabled devices
15. Supports multiple embedded audio formats
16. Bidirectional RS-232 and IR pass-through for AV device control
17. Digital conversion of analog input signals

18. HDCP compliant — Ensures display of content-protected media and interoperability with other HDCP-compliant devices.
19. User-selectable HDCP authorization
20. EDID Minder® automatically manages EDID communication between connected devices
21. HDCP authentication and signal presence confirmation
22. HDCP Visual Confirmation
23. Output muting control
24. HDMI to DVI Interface Format Correction
25. Automatic color bit depth management
26. Front panel security lockout
27. Compatible with all DTP 230 Series receivers and DTP-enabled products
28. RS-232 control port
29. Contact closure remote control with tally output
30. Compatible with TeamWork® Show Me® Cables
31. Front panel USB configuration port
32. LED indicators for signal presence, HDCP, and power
33. RJ-45 signal and link LED indicators for DTP port
34. Easy setup and commissioning with Extron's PCS
35. JITC Certified
36. 1" (2.5 cm) high, half rack width metal enclosure
37. Includes LockIt® HDMI cable lacing brackets
38. External Extron Everlast™ power supply included, replacement part #70-967-01
39. Extron Everlast Power Supply is covered by a 7-year parts and labor warranty
40. Acceptable product:
    a. Extron DTP DSW 4K 233

G. Multiformat Transmitter Decora
1. Transmits HDMI, VGA, control, and analog audio up to 330 feet (100 meters) over a shielded CATx cable
2. inputs: One HDMI, one VGA on 15-pin HD, two 3.5 mm stereo mini jacks for audio
3. Output: One DTP® 330 twisted pair output on RJ-45
4. Auto-switching between inputs
5. Supports computer and video resolutions up to 4K
6. Analog stereo audio embedding
7. Remote power capability
8. Extron XTP DTP 24 shielded twisted pair cable is strongly recommended for optimal performance
9. Compatible with CATx shielded twisted pair cable
10. Independent analog audio inputs
11. Supported HDMI specification features include data rates up to 10.2 Gbps, 3D, and HD lossless audio formats
12. Supports multiple embedded audio formats
13. Bidirectional RS-232 pass-through for AV device control
14. Digital conversion of analog input signals
15. HDCP compliant
16. User-selectable HDCP authorization
17. HDMI to DVI Interface Format Correction
18. Automatic color bit depth management
19. Compatible with all DTP 330 Series receivers and DTP 330-enabled products

20. RS-232 control port
21. Contact closure control port
22. Front panel USB configuration port
23. LED indicators for signal presence, HDCP, and power
24. RJ-45 signal and link LED indicators for DTP port
25. Easy setup and commissioning with Extron's PCS - Product Configuration Software
26. Mounts in an included two-gang decorator-style wall plate
27. External Extron Everlast™ power supply included, replacement part #70-1174-01
28. Extron Everlast Power Supply is covered by a 7-year parts and labor warranty
29. Acceptable product:
    a. Extron DTP UWP 4K 332 D

H. HDMI Receiver Decora
1. Receives HDMI plus control and analog audio up to 230 feet (70 meters) over a shielded CATx cable
2. Input: One DTP® 230 twisted pair input on RJ-45
3. Outputs: One HDMI, stereo audio on captive screw
4. Supports computer and video resolutions up to 4K
5. Supported HDMI specification features include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
6. HDCP 2.2 compliant
7. Remote power capability
8. Extron XTP DTP 24 shielded twisted pair cable is strongly recommended for optimal performance
9. Compatible with CATx shielded twisted pair cable — Shielded twisted pair cabling with solid center conductor sizes of 24 AWG or better is recommended for optimal performance.
10. Accepts additional analog stereo audio signals
11. Bidirectional RS-232 and IR pass-through for AV device control
12. Supports multiple embedded audio formats
13. Supports EDID and HDCP transmission
14. Compatible with all DTP 230 Series transmitters and DTP-enabled products
15. LED indicator for signal presence and power
16. RJ-45 signal and link LED indicators for DTP port
17. JITC Certified
18. Mounts in an included single-gang decorator-style wall plate
19. Optional, external Extron Everlast™ power supply available, part #70-1174-01
20. Extron Everlast Power Supply is covered by a 7-year parts and labor warranty
21. Acceptable product:
    a. Extron DTP R HWP 4K 231 D

I. HDBASET Extender (Classrooms, Collaborative Area's, Resource Rooms, Student Support, Library Commons):
1. Extend HDMI, USB, RS232, and
2. IR up to 328ft over UTP
3. High Definition Digital 4K @ 60Hz
4. Video and Audio with Control
5. Utilize Same Cable for Current and Future Applications
6. Locating a display device up to 328 feet (100m) away is as simple as pulling one UTP cable to a drop

7. Terminate with one Category 6A, 6 or 5e UTP or shielded, plenum or non-plenum cable
8. Supplied as a kit with both Source and Display modules
9. Acceptable product:
    a. Hubbell iStation SFHD4BK , (2) Cables to Go 56783, and all required power supplies, PoE injectors, and associated cables.

2.5 CONTROL SYSTEMS

A. AV Controller Type 1

1. Supports TouchLink Pro touch panels, eBUS® button panels, and Network Button Panels
2. Supports secure industry standard communications protocols
3. One bidirectional RS-232/RS-422/RS-485 serial port with hardware and software handshaking
4. Two IR/Serial ports for one-way control of external devices
5. Four Digital I/O ports
6. Four relays for controlling room functions
7. eBUS port for connecting eBUS button panels and accessories
8. Ethernet monitoring and control
9. Central Deployment
10. Supports popular BMS
11. Integrated three port network switch
12. Supports 10/100/1000Base-T
13. Supports Ethernet-controllable devices
14. Integrated IR Learning capability
15. Automatic clock synchronization allows touch panel to display the accurate time and date
16. Supports control system synchronization
17. Front panel port status indicators
18. Multi-level password protection
19. 1U, half rack width metal enclosure
20. External Extron Everlast™ power supply included, replacement part #70-1174-01
21. Acceptable product:
    a. Extron IPCP Pro, with Extron RSU 126 as required.

B. Touch Panel (TP1)

1. 5″ capacitive touchscreen with 800x480 resolution and 24-bit color depth — Vibrant edge-to-edge glass display with a more responsive control surface.
2. Gorilla Glass® screen is tough, scratch, and smudge-resistant — Corning Gorilla Glass is stronger and more scratch-resistant than standard glass, while maintaining touch sensitivity, color saturation, and brightness.
3. Faster, quad-core processing and eight times more memory — Drastically-enhanced response and overall user experience
4. Compatible with all IP Link Pro control processors
5. Power over Ethernet provides power and communication over a single Ethernet cable
6. Built-in speaker — Provides audible feedback from button presses.
7. Light sensor adjusts screen brightness as the ambient room lighting changes
8. Configurable red and green status lights indicate a room's availability or call status
9. System connection status indicator provides visual feedback if the touch panel is not communicating with a control processor

10. High speed USB 2.0 port — For future expansion.
11. Automatic clock synchronization allows touch panel to display the accurate time and date
12. Energy-saving features:
13. - Adjustable sleep timer puts touch panel into sleep mode
14. - Motion detector wakes touch panel
15. Fixed 65 degree viewing angle provides optimum viewing comfort while seated or standing
16. Kensington lock support — Allows the touch panel to be locked to a table or other flat surface.
17. Manage, monitor, and control this device remotely using GVE - GlobalViewer Enterprise Resource Management software
18. Fully customizable using Extron control system software — GUI Designer combined with Global Configurator Plus, Global Configurator Professional, or Global Scripter.
19. Supports the optional SMA-2 Swivel Mount Adapter
20. Contemporary design that complements the aesthetics of any environment
21. Highly reliable, energy-efficient external universal power supply optional, replacement part #70-778-01 — Provides worldwide power compatibility, with high demonstrated reliability and low power consumption for reduced operating costs.
22. Acceptable product:
    a. Extron TLP Pro 525

2.6 MISCELLANEOUS EQUIPMENT

A. EQUIPMENT RACKS (JB1)

1. Robust welded steel construction
2. Patented Tool Free Quick-Mount™ system for center section mounting
3. Center section swing shall be reversible, and be both key locked and padlocked
4. Durable textured black powder coat finish
5. Provide with vented front door
6. Provide with lacing bars
7. Provide with lacing strips
8. Provide with fan kit
9. Provide with locking drawer
10. Provide with power conditioner
11. Provide with blank panels
12. Provide with LED work light
13. Acceptable Product:
    a. Middle Atlantic BGR 4532 with Middle Atlantic UPS S2200R, SurgeX SEQ as required, and CommScope 1933322-2, (12) Belden 1302E, (48) Belden C6F1106007, and all required accessories, or approved equal

B. Equipment Rack (Performance Classrooms)

1. Rack Enclosure
2. Rack Unit: 20
3. Finish: Grained Ebony Ash
4. Material: Wood
5. Panel Width: 19"
6. Mounting: Horizontal
7. UL Standards Tested: UL1678

8. UL Load Capacity: 250
9. Rack rail Type: 10-32
10. RoHS Compliant
11. Internal steel bracing for strength
12. Designed for passive cooling
13. Provide with lacing bars
14. Provide with lacing strips
15. Provide with fan kit
16. Acceptable product:
    a. Middle Atlantic MFR 2027GE with SurgeX SX1120RT

C. Wall Mounted Equipment Rack (Gym)

1. Rack Enclosure
2. Rack Unit: 20
3. Finish: Grained Ebony Ash
4. Material: Wood
5. Panel Width: 19"
6. Mounting: Horizontal
7. UL Standards Tested: UL1678
8. UL Load Capacity: 250
9. Rack rail Type: 10-32
10. RoHS Compliant
11. Internal steel bracing for strength
12. Designed for passive cooling
13. Provide with lacing bars
14. Provide with lacing strips
15. Provide with fan kit
16. Acceptable product:
    a. Middle Atlantic DWR 24 26 with SurgeX SX1120R

D. Surge Suppressor (At all displays and projector(s))

1. Load Rating: 8 amps @ 120 volts
2. Power Requirement (no load): 10 watts
3. Surge Let-Through Voltage (6000-volt surge): 0 volts
4. UL 1449 Adjunct Classification Test Results: 1000 surges, 6000 volts, 3000 amps, B3 pulse; Measured suppressed voltage: 170 volts; no failures
5. Federal Guidelines: Grade A, Class 1, Mode 1 (CID A-A-55818)
6. EMI/RFI Filter, Normal Mode (50-ohm load): 40 dB @ 100 kHz; 50 dB @ 300 kHz; 50 dB @ 3 MHz; 50 dB @ 30 MHz
7. EMI/RFI Filter, Common Mode (50-ohm load): 18 dB @ 300 kHz; 30 dB @ 1 MHz; 50 dB @ 5 MHz; 50 dB @ 20 MHz Maximum Applied Surge Voltage: 6000 volts. *
8. Acceptable product:
    a. SurgeX SA-82, or approved equal

E. HDMI Cable

1. Ultra-flexible HDMI cables
2. Provide as required between HDMI devices and one at each input location.

3. Conforms to Premium High Speed and High-Speed HDMI cable performance standards
4. 4K/60 verified up to 12 feet (3.6 m)
5. 4K/30 verified for 15 feet (4.5 m)
6. Acceptable product:
    a. Cables To Go 56783 as required, or approved equal

F. VGA +audio cable

1. Thin, flexible cable with low profile VGA connectors
2. Provide as required at each VGA input location.
3. Pin 9 is passed through from end to end
4. Designed for transmission of computer video, ID bit signals, and audio
5. Terminated with high quality molded VGA connectors and 3.5 mm connectors for audio
6. Acceptable product:
    a. Extron MVGA-A M-M/6, as required or approved equal

G. USB 3.0 to A 6' Cable

1. Carries USB 3.0 data signals and power
2. Up to 4.8 Gbps bandwidth
3. Shielded to protect from interference
4. Acceptable product:
    a. Cables To GO 54171 as required or approved equal

2.7 PLATES AND PANELS/FLOOR BOXES

A. Provide plates and panels as described and/or detailed in the drawings and as required for fully operable system(s).

B. Custom plates shall be 1/8" thick aluminum, standard EIA sizes, sized to cover rough- in boxes behind plates.

C. Plastic plates are not allowed or accepted.

D. Lettering shall be in all caps and numbers engraved with black or white lettering to the base material with a minimum size of 0.25".
1. Font Size shall be 1/8"
    a. Font Style shall be Helvetica

E. Acceptable manufacturer of custom plates and panels shall be:
1. RCI Custom – AL and/or ALOS series Aluminum Wall Plates
    a. Provide AL series Aluminum Plates for floor and in wall box assemblies.
    b. Provide ALOS series Aluminum Plates for wall boxes.
    c. Or approved equal

2.8 PROPOSED SUBSTITUTIONS

A. Where specific equipment is described, it is not the intention to discriminate against the products of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.

B. The Owner's Representative and or Consultant requires manufacturer's original specification tests. The Owner's Representative and or Consultant will evaluate and approve and/or disapprove all substitutions.

C. Items designated "no substitutions" shall be that specified item only. Submission of items other than specified shall not be considered and may disqualify RFP submission.

2.9 CABLES AND WIRING

A. All audio cable shall be stranded copper conductors.

B. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

C. Plenum Rated and/or Non-Plenum Ratings: Cable routed in conduits and or equipment racks can have non-plenum rated (PVC) jacket. All other cables shall have a plenum or riser rated jacket compliant to the cable run and purpose. Cable runs shall be continuous without splices.

D. Cable Selection: Based on signal type as indicated on single line diagram, noted at equipment input, or output connection type. Wire manufacturer and part numbers are provided as a basis of cable quality and signal characteristics. Alternate cable manufacturers to be requested for approval during pre-build submittal.

E. Cable Types:
   1. Microphone and Line Cable:
      a. Configuration: Twisted pair, 22 AWG West Penn 291 plenum 25291
   2. Low Impedance Loudspeaker Cable: (Select gage based on cable run and wattage)
      a. Configuration: Twisted pair, 8 AWG West Penn C208
      b. Configuration: Twisted pair, 10 AWG West Penn C210 plenum 25210
      c. Configuration: Twisted pair, 12 AWG West Penn C227 plenum 25227
      d. Configuration: Twisted pair, 14 AWG West Penn C226 plenum 25226
   3. High Impedance Loudspeaker Cable (25V / 100V) (Select gage based on cable run and wattage)
      a. Configuration: Twisted pair, 14 AWG West Penn C226 plenum 25226
      b. Configuration: Twisted pair, 16 AWG West Penn C225 plenum 25225
      c. Configuration: Twisted pair, 18 AWG West Penn C224 plenum 25224
   4. Wireless Microphone Antenna Cables with-in equipment racks: (Select type based on cable length and signal loss)
      a. Configuration: RG-58/U solid center conductor West Penn 812 plenum 25812
   5. Wireless Microphone and Hearing Assistance Antenna Cables outside of equipment racks
      a. Configuration: RG-8/U solid center conductor West Penn 98G8 plenum 2598G8
   6. Video Tie Line Cable: Digital Video SDI, HD-SDI
      a. Configuration: RG-59/U 20 AWG solid center conductor precision video cable West Penn 819 plenum 25819
      b. Configuration: RG-59/U 25 AWG solid center conductor precision video cable West Penn HD825 plenum HD25825
      c. Configuration: RG-59/U 20 AWG solid center conductor precision video cable Belden 8281
   7. Network Cable for video and audio streaming transport. (H.264, Cobranet HDBaseT and Daunte)
      a. Unshielded Twisted pair Category 5e Cabling West Penn Wire 254245
      b. F/UTP Category 6 Cabling West Penn Wire 254246AF
      c. Shielded Twisted pair HDBaseT Cabling Extron XTP DTP 24
   8. RS-232 Control Cable
      a. Configuration: Twisted pair, 22 AWG West Penn 291 plenum 25291
      b. 9-conductor 22AWG. communications cable: Belden 9945.
      c. 9-conductor 18AWG. communications cable: Belden 83659.

9. HDMI (High-Definition Multimedia Interface)
    a. Carries
10. DisplayPort
    a. Carries
11. 75 Ohm video and/or RF Cabling
    a. Trunk video cable (RG6): West Penn 841 plenum 25841
    b. Trunk video cable (RG11): West Penn 821 plenum 25821
    c. RF CATV cable (RG6): West Penn Q841 plenum 25Q841
    d. RF CATV cable (RG11): West Penn Q 821 plenum 25 Q 821
12. Cable manufacturer recommendations:
    a. West Penn Wire and Cable
    b. Belden
    c. Extron
    d. Crestron
    e. AMX
    f. Substitution: By approved substitution means.

2.10 LOUDSPEAKER CLUSTER RIGGING AND/OR ANY CUSTOM FLYWARE

A. Provide rigging, hardware, suspension cables, and all appropriate hardware for the clusters as required for a fully operable system. Including any necessary support steel or additional steel required for proper rigging and suspension. A structural engineer licensed by the state where the installation will take place shall approve the rigging system by stamping all relevant drawings. All calculations shall be provided with the stamped rigging diagrams submitted along with the pre-build submittals.
    1. Acceptable manufacturers for all mounting bars and trusses:
        a. ATM Flyware,
        b. Custom by Speaker Manufacturer
        c. Engineered approved custom.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing.

B. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.

C. Units shall be installed parallel and square to building lines. All wires shall be gathered and fastened to create an orderly installation.

D. Electronic equipment shall be permanently mounted in equipment racks or as applicable to the equipment and application.

E. Contractor shall follow all applicable ANSI / INFOCOMM standards as a basis of design, fabrication, construction, and Performance Verification.

F. Provide shaft locks or security covers on non-user operated equipment having front panel access.

G. Install XLR-type connectors wired as follows: Pin 2 High, Pin 3 Low, and Pin 1 Shield.

H. Mount all equipment, speakers, plates and panels, plumb and level.

I. Permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.

J. Contractor shall validate bracing or blocking for proper mounting and safety.

K. Contractor shall provide seismic bracing for appropriate equipment where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 EQUIPMENT HOUSING

A. Equipment Enclosures and/or Racks:

1. Install all audiovisual equipment within equipment racks according to manufacturer's recommendations and product application.
2. Provide adequate ventilation, thermal management and temperature-controlled fans to maintain a rack temperature of less than 85 degrees Fahrenheit.
3. Provide rear support and rear rack rails for housing mounted equipment greater than 15" deep.
4. Allow a minimum of 20% open rack space to support future expansion.
5. Fill all empty spaces with blank panels, sizing as required; painted and or anodized to match housing.
6. Locate operator useable equipment and patch panels at an appropriate operating height.
7. Key all door locks for each housing type (front, rear) alike.
8. Looking at the equipment racks from the rear of the racks, install all AC power and ground cabling on the left and audio and video cabling on the right.
9. Provide LED lights mounted in the top of every two racks to illuminate the interior for service or maintenance. LED lights shall be individually switch-able and placed so as to provide maximum illumination throughout the rack.
10. Dress all loose cabling for a clean and orderly rack. The use of electrical tape for cable management is prohibited.
11. The use of tie wraps for network UTP, STP, and optical fiber cabling is prohibited.
12. Provide nylon braded sleeving for wiring harnesses for a clean installation of cabling that is visible to user areas. Sleeving color shall be coordinated with location and device color.

3.3 PATCH PANELS

A. Audio Patch panel configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tie-lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any console connections and interconnection of rooms and equipment.

B. Video Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.

2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tie-lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any device connections and interconnection of rooms and equipment.
8. Unshielded Twisted Pair UTP and/or STP RJ-45 Patch Panel Configuration:
9. Patch panel shall be located in designated racks as shown on drawings.
10. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
11. Configure and terminate patch bay per TIA / EIA standards.

3.4 LABELING

A. Device Labeling:
   1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
   2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

B. Rack Labeling:
   1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
   2. All rack panel labeling shall be engraved and filled.

C. Wire and terminal strip labeling:
   1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
   2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
   3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
   4. Wiring designator shall be alphanumeric code, unique for each cable.
   5. Each cable type shall be labeled starting with different destinations (i.e. mic series "Mxxx", speaker series "Sxxx", etc.).
   6. On projects that have multi room connectivity the source and destination room numbers should be the prefix for the cable number indicting a cable that traverses between two rooms.
   7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.5 LOUDSPEAKER SUSPENSION

A. Requirements:
   1. All loudspeakers shall be suspended or mounted at the appropriate operating position in a safe, secure and permanent manner.

2. The aiming direction of all loudspeakers and speaker clusters shall be adjustable in plus or minus 5-degree increments.
3. All loudspeakers enclosures being flown or suspended shall have internally integrated mounting brackets to distribute the load to the rigging points on each speaker cabinet. Contractor shall provide internal bracing as required if not incorporated into the speaker cabinet by the manufacturer.
4. At all times, speakers to be mounted or flown shall be intentionally designed for the purpose of suspension with integrated rigging points designed into the speaker cabinet by the manufacturer.
5. All loudspeakers shall have permanently attached grilles with all manufacturer logos removed.
6. All loudspeaker cables/wiring shall disconnect from a junction box located in the same speaker cavity as the speakers or clusters. Provide a single loudspeaker cable assembly that connects from the junction box to the speaker cluster and allows cable length for testing and powering the cluster while assembled on the floor.
7. Structural support members shall have a safety factor of at least 5:1.
8. All mounting hardware and wire rope shall have a safety factor of 8:1.
9. All fasteners, bridles, carabineers, quick links, shackles, etc. shall be of forged material and shall be manufactured for rigging.
10. All speakers, speaker clusters, and rigging equipment shall be painted the same color if exposed to the public areas
11. Certification Requirement:
    a. All rigging, mounting, and support systems for the loudspeaker clusters or suspended speakers shall be reviewed and certified by a registered Structural Engineer licensed in the state of the project. Once the systems are installed, the engineer shall physically inspect the methods and means used for the installation and verify that the installation complies both with the certified documents and code practices. A document from the Structural Engineer stating this compliance shall be supplied to the Owner before any final payments will be authorized.
    b. The Loudspeaker clusters shall not be installed before Engineer's certification has been submitted. Stamped approval of all rigging shall be made from this same Engineer within the state of the project.

3.6 OUTDOOR EQUIPMENT MOUNTING

A. Outdoor Mounting Requirements:
1. All outdoor mounting hardware shall be non-corrosive.
2. Any exposed structural supports for speakers or other outdoor components shall be non-corrosive or covered with an inhibiting layer.
3. Any components mounted outside shall be secured in such a way as to prevent movement caused by wind or storms.
4. All speaker, microphone, line, and communications enclosures to include grill components capable of protecting the devices and keep the water and elements out of the components.
5. Seal all connections on each speaker with a waterproof silicone sealant.
6. Provide screened covering over all openings in horn type enclosures to keep out birds, insects, or small animals.

3.7 PERFORMANCE STANDARDS

A. Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise required under the Detailed Specifications, the following performance standards shall be met within each system:

1. Audio
   a. Frequency Response
      1) Within plus or minus 0.5dB, 20 Hz to 20,000 Hz.
   b. Signal to Noise Ratio
      1) greater than 90dB (including crosstalk and hum at all input/output levels)
   c. Total Harmonic Distortion
      1) 0.05% maximum from 20 Hz to 20,000 Hz.
   d. Microphone (Nominal): -50dbu
      1) Overload (Minimum gain): -5dbu
      2) Maximum Gain: -26dbu
   e. Line (Nominal): +4dbu (-10dbu RCA connections)
      1) Overload (Minimum gain): +24bu
      2) Maximum Gain: +9dbu
2. HDMI (High-Definition Multimedia Interface)
   a. HDMI, EIA/CEA-861 standard
   b. Data protocol: transition minimized differential signaling (TMDS)
   c. Bit Rate: Up to 18 Gbit/s in HDMI 2.0
   d. Audio Signal: LPCM, Dolby Digital, DTS, DVD-Audio, Dolby Digital Plus, Dolby TrueHD, DTS-HD High Resolution Audio, DTS-HD Master Audio, MPCM, DSD, DST
   e. HDCP and EDID capable
   f. Cable length 5-10 meters depending on cable type, further distances are achieved with active extender devices.
3. Serial Digital Interface (SDI) per SMPTE standards as listed below
   a. HD-SDI – SMPTE 292M – data rate of 1.485 Gbit/s – single coax
   b. 3G-SDI – SMPTE 424M – date rate of 2.970 Gbit/s – single coax
   c. 6G-SDI – 6Gbit/s – 10-bit, 4:2:2 - single or dual coax
4. DVI (Digital Visual interface)

   a. Achieved with active extender devices.
5. DisplayPort
   a. Low-voltage differential signaling, (LVDS), TIA/EIA-644,
   b. Data protocol: Mini-packet
   c. Bitrate: 1.62, 2.7, 5.4, or 8.1 Gbit/s data rate per lane; 1, 2, or 4 lanes; (effective total 5.184, 8.64, 17.28, or 25.92 Gbit/s for 4-lane link); 1 Mbit/s or 720 Mbit/s for the auxiliary channel. HDCP and EDID capable
   d. Cable length from 3-5 meters depending on cable type, further distances are achieved with active extender devices.
6. Apple Thunderbolt
   a. Carries video, audio, and auxiliary data from source to display devices
   b. 20 Gbit/s max
   c. 3-meter cable length via copper cable, further distances are achieved with active extender devices.
      a) Wireless Video Technologies

2) Computer Transport
   a) Based on IEEE 802.11 a/g/n standard
   b) Encryption AES CCMP
   c) Authentication Protocol WPA2-PSK
   d) Minimum input resolution WUXGA (1920x1200)
   e) Minimum output resolution WUXGA (1920x1200)
   f) Minimum frame rate 30 fps.
   g) Latency: less than .5s or better.

d. Universal Serial Bus (USB) Transport
   1) USB over unshielded twisted pair (UTP) active extender
      a) Extends USB components from processor using a single or dual UTP cable.
      b) Maximum of 330' (100M)
      c) Shall support USB 3.0, 2.0, 1.1, and 1.0 devices with data transfer rates up to 480 Mbps Authentication Protocol WPA2-PSK
      d) USB host support xHCI (USB 3.0), EHCI (USB 2.0), OHCI/UHCI (USB 1.1)
      e) USB data rates Low speed (1.5 Mbps), full speed (12 Mbps), high speed (480 Mbps)

e. Networked based video and audio transport and recording protocols
   1) Network based video and audio streaming and recording standards are constantly being updated and improved and as such this section references specific standards and their current features / capabilities.
   2) H.264 MPEG 4 AVC
      a) Current Bit depth: (per sample) variable from 8 to 14 depending on selected feature.
      b) Current Features: allow video transport to provide more flexibility for application to a wide variety of network environments.
      c) Current Supported chroma formats: 4:2:0 / 4:2:2 / 4:4:4
   3) H.265
      a) H.265 is an emerging standard based on H.264 allowing for better higher resolution video quality using lower transmission rates.
   4) JPEG 2000
      a) Shall conform to ISO/IEC 15444 standard

f. Video and Audio teleconference
   1) Video Conference: Integrated Services Digital Network (ISDN)
      a) This is an older interface connection that is used within legacy systems and equipment that is based on the ITU H.320 I standard
      b) ISDN interface consists of basic(s) Rate Interfaces (BRIs), a 128 kbit/s service delivered over a pair of standard telephone copper wires. The 144 kbit/s payload rate is broken down into two 64 kbit/s bearer channels ('B' channels) and one 16 kbit/s signaling channel ('D' channel or data channel).
   2) Video Conference: Internet Protocol (IP)
      a) Based on the ITU H.264 Scalable Video Coding (SVC) standard
   3) Audio Conference: Plain old Telephone Service (POTS)
      a) Analog legacy phone interface based on WT 89-66-15 Quality standards.
   4) Voice over IP (VoIP) telephone

a) Based on the H.323 Standard as well collaborative protocols to include:
b) Media Gateway Control Protocol (MGCP)
c) Session Initiation Protocol (SIP)
d) H.248 (also known as Media Gateway Control (Megaco))
e) Real-time Transport Protocol (RTP)
f) Real-time Transport Control Protocol (RTCP)
g) Secure Real-time Transport Protocol (SRTP)
h) Session Description Protocol (SDP)
i) Inter-Asterisk eXchange (IAX)
j) Jingle XMPP VoIP extensions
k) Skype protocol
l) Teamspeak
m) Manufacture specific code for SIP interfaces differ so if differing manufactures are used within a VoIP phone system then care must be taken to ensure that needed functions are intercomparable between manufactures.

g. Control System User Interface

1) Panel layouts and configurations shall be submitted for approval with or closely associated with the pre-build submittal package.
2) Control system user interfaces pages shall be designed for this project exclusively. While there are a great number of design approaches to designing the user interface, the following guidelines shall be adhered to:

h. Provide user and technical control functions and pages for all touch panels as well as for web controls.
i. Control functionality shall be arranged in an intuitive fashion based on specific room uses and device functions. A separate password protected logon would provide technical support access that would include all device specific functions and commands.
j. All panels are to have the time and date as icons, in the same position on every page.
k. All panels are to have a title, indicating the piece of equipment and/or functionality being controlled.
l. Each individual room type shall be given the same user interface design and layout, throughout the entire campus, to the greatest extent practicable.
m. User interface design, shall, to the greatest extent possible – taking into account the variations in system functionality from room type to room type, maintain continuity throughout the campus.
n. Final programming shall include capability to remotely control all functions of the Audio system. Individual device controls shall provide full manufacturer's functionality.
o. Devices similar in nature shall be programmed to operate with a common format.
p. No individual component shall be programmed to function atypically.
q. Whenever the same button appears on more than one page, it will be in the same position on each page.
r. Functions used during a general presentation shall be accessible with a minimal amount of button presses/page flips.
s. Where feasible, multi-level access to controls should be implemented.
t. User help screens shall be included as part of the touch panel designs.

3.8 CONTRACTOR TESTING AND OR COMMISSIONING

A. Prior to energizing or testing the system(s), ensure the following:
   1. All products are installed in a proper and safe manner per the manufacturers' instructions.
   2. Insulation and shrink tubing are present where required.
   3. Dust, debris, solder, splatter, etc. is removed.
   4. Cable is dressed, routed, and labels and all connections are consistent with regard to polarity.
   5. All labeling has been provided and installed.
   6. All products are neat, clean, unmarred and securely fastened.
   7. All debris has been cleaned and removed from the site.
   8. All electronic devices are properly grounded.

B. Perform the following test. Record all results in the final project manual.
   1. Test each AC power outlet for proper connections for hot, neutral and ground.
   2. Measure and record the DC resistance for the technical ground in the equipment racks and console. Resistance should be 0.15 ohms or less.
   3. Measure the impedance of each speaker line from the amplifier rack.

3.9 PERFORMANCE AUDIO SYSTEM TESTS

A. Speaker Verification Test:
   1. Provide a low-level distinctive tone to each amplifier input.
   2. Systematically turn on each amplifier, one by one, and verify that the correct speaker is being driven. Correct wiring as required for proper operation.

B. Constant Voltage Speaker test:
   1. Provide a low-level distinctive tone to each amplifier input.
   2. Systematically turn on each amplifier, one by one, and verify that the correct speaker is being driven. Correct wiring as required for proper operation.
   3. Walk the areas covered by the speakers and check for even level volume coverage. Adjust any speakers that are not correct by changing tap values as required for even volume level.

C. Speaker Polarity:
   1. Use an electronic polarity checker to test each reinforcement speaker. All speakers should have the same relative polarity.

D. System(s) Gain Adjustment:
   1. Adjust each active device to have unity gain from the console output to the input of the amplifiers.
   2. With all amplifiers turned off, connect a sine wave and pink noise to an input of the console. Using an RMS voltmeter, adjust the scale to an output between -10 and 0dBu. Once level has been established, it should remain unchanged throughout the testing.

E. Signal Delay Adjustment:
   1. Adjust the delay speakers to ensure proper synchronization between the main speakers and the delayed speakers.
   2. Using TEF20 or SMARRT Live measure and adjust the arrival times of each speaker to be fully synchronized.

F. Amplifier Level Adjustment:
   1. Adjust the gain of each amplifier to provide consistent and appropriate levels throughout the seating areas/facilities.
   2. With the console and other electronic devices feeding the amplifiers adjusted as described above, adjust the output of the console to be -10dB on the output VU meter.

3. Adjust the appropriate amplifiers to achieve 85dBA in the area covered by one of the speakers. Use a calibrated sound level meter to make the adjustments.
4. If the speaker is utilizing an active crossover, mute the individual bandpass sections to adjust each section independently.
5. Start with the speaker closest to the stage area or the booth location as appropriate. Once that speaker has been adjusted to the above criteria, repeat this procedure for each speaker cabinet.
6. Amplifiers should be set to provide an average of 85dBA plus or minus 1.5dB throughout each seating section.

G. Amplifier Level Adjustment 70-volt System:
1. Adjust the level of the 70-volt systems to achieve a volume level appropriate for their location and intended use.
2. After initial amplifier adjustment, walk all areas utilizing the 70-volt systems and check for volume uniformity. If any changes of 3dB or more occur, adjust that specific area or speaker as required for even coverage.

H. Input Verification Test:
1. Using a microphone, portable signal generator, or CD player, send signal from every microphone input to the console. Check every connection location in the facility.
2. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
3. Verify that the receptacle under test appears at the correct position on the patch bay and is operating properly.
4. In a similar manner, check any other inputs or tie lines, as appropriate.

I. Impedance:
1. Measure absolute impedance value of each loudspeaker line at 250, 500, 1000, and 2000 Hz without the amplifier connected but with all speakers connected. Record the impedance levels versus frequency for each loudspeaker line.
2. Impedance must not be below the rated load impedance of respective amplifier and may be any value equal to or above that.
3. Check the resistance of the lines for loudspeaker, line level, and microphone receptacles with the receptacles opened and shorted. Document and repair any shorts or discontinuities found.

J. Polarity:
1. Verify the polarity of each device in the shop to obtain true polarity throughout the system.
2. Verify and document that polarity is kept throughout the system after wiring from inputs through output devices or receptacles.

K. Gain Structure:
1. Turn off amplifiers and set equalizers and filter controls to flat response. Do not bypass any equalizers or filters.
2. Adjust compressors and limiters to a 1:1 compression ratio and a +10 dBu limiting threshold. Do not bypass these processors.
3. Insert pink noise into the mixer or mixing console and adjust levels to obtain a 0 dBu reading for the mixer or mixing console output. Distribute this output to all systems and subsystems.
4. Adjust the output of line level electronics and signal processors to obtain a 0 dBu output at the output terminals. For equipment with input level controls, adjust the input controls so that input levels peak at -10 dB. For equipment not capable of providing 0 dBu output, adjust to achieve as close to 0 dBu as possible.

5. Turn amplifier gain controls to minimum and turn on the power amplifiers. Adjust the gain controls to achieve a +4 dBu output level for low impedance amplifiers and a +18 dBu output level for high impedance or constant voltage amplifiers.

L. Hum and Noise Level:
1. Without changing the gain, terminate microphone and line level inputs with proper shielded resistors of 150 and 600 ohms respectively.
2. Measure and record overall hum and noise levels for each power amplifier output from each input and with all inputs simultaneously. Hum and noise shall be at least 50 dBA below rated power output levels with amplifier controls set for optimum signal-to-noise, using input from line level and microphone sources.

M. Electrical Distortion:
1. Load amplifier outputs with appropriate resistors matching the nominal impedance of the output terminals in place of the actual loudspeaker loads.
2. Adjust gain controls as for hum and noise level test.
3. Apply 250 Hz, 500 Hz, 1 kHz, and 2 kHz sine wave signal from an oscillator with less than 0.01% Total Harmonic Distortion to one input, such that a level of 0 dBu is obtained on the mixer.
4. Measure and record the electrical distortion at each power amplifier output. Distortion shall be less than 0.5%.

N. Parasitic Oscillation and Radio Frequency Pick-up:
1. Set up system for each specified mode of operation.
2. Using a 5 MHz bandwidth oscilloscope and loudspeaker monitoring.
3. Ensure that the system is free from spurious oscillation and RF pick-up with the absence of any input signal and with a 160 Hz signal at a 0 dBu level on the mixer or mixing console.
4. Repeat this test for each mode of operation of the lighting dimmers (incandescent, neon, and fluorescent).

O. Background Noise:
1. Using a calibrated ANSI S1.4-1983 (1997) Type 1 or IEC 60651-01-1994, precision sound level meter, determine the average ambient noise level in the room. Record the level derived. The average background noise shall be 60 dBA or below during performance of the following tests. If noise level exceeds this criterion, promptly notify the Consultant before proceeding further.

P. Buzzes and Rattles:
1. Apply a 1 kHz sine wave signal such that a 0 dBu level is obtained on the mixer or mixing console.
2. Sweep loudspeaker systems from 50 Hz to 5 kHz at 6dB below full amplifier power. Listen for buzzes, rattles, vibrations or resonance. Locate and correct problems.
3. If the cause is outside the system, promptly notify the Consultant, indicating the cause and recommended corrections.

Q. Coverage:
1. Using pink noise as an input, adjust loudspeakers and output levels to provide ±6 dB coverage in the octave band centered at 1 kHz throughout the areas served by the system.
2. Measure and record results.

R. Equalization:

1. Equalize the sound systems in order to provide uniform seat-to-seat response, raise the threshold of feedback, suppress ring modes, and insure natural, pleasing sound in equal and adequate amplitude with maximum degree of intelligibility, and provide performance conforming to the requirements specified under "Acceptance Testing."
2. Turn off systems except the speaker system under test.
3. Using pink noise as an input and with system equalizers set to bypass operation, determine the average frequency response of the loudspeaker system in the room using a 1/3 octave real time analyzer.
4. Record the frequency response derived.
5. Locate the analyzer microphone approximately 1 m above the floor at a point which approximates the average frequency response, within ±3 dB from 50 Hz to 16 kHz.
6. Record the frequency response at this location.
7. Using pink noise as an input and with system equalizers set to normal operation, set low and high pass filters at 63 Hz and 16 kHz respectively.
8. Adjust the 1/3 octave filter settings to obtain the following response curves, minimizing the variation (±3 dB) between adjacent filter settings:
   a. Roll off -6 dB per octave below 125 Hz.
   b. Maintain ±3 dB, 125 Hz to 4 kHz.
   c. Roll off -3 dB per octave from 4 kHz to 12 kHz.
   d. Roll off sharply above 12 kHz.
   e. With any system microphone open, make minor adjustments to maximize gain before feedback. No more than 3 filter settings shall be adjusted.
   f. Record the frequency response derived.

S. System Input and Output Levels
1. Using pink noise source material and a calibrated ANSI S1.4-1983 (1997) Type 1 or IEC 60651-01-1994, precision sound level meter, perform the following:
   a. For microphone level inputs: locate a pink noise source at a distance of 300 mm from the corresponding system microphone. Adjust the pink noise source to provide a level of 75 dBA at the microphone and set mixer levels to achieve a 0 dBu level at the mixer output.
   b. For line level inputs: use system program source equipment, with pink noise playback media, as a direct input to the mixer or mixing console and set mixer levels to achieve a 0 dBu level at the mixer output. Repeat for each system input individually where mixer inputs vary in input sensitivity. Settings for equivalent sensitivity inputs may be duplicated.
   c. With any input set as specified above, adjust audio distribution amplifiers to provide levels of -10 dBu at each output.
2. Measure and record results.

T. Feedback Stability:
1. With required output levels set, measure and record the available gain before feedback. Feedback stability margin shall be 6 dB, minimum.

U. Intelligibility:
1. Using a TEF analyzer or similar, measure the percent articulation loss of consonants (% ALcons) for at least 4 various locations in the room in the 2000 Hz octave band.
2. % ALcons shall be less than 10 for each location.
3. Record results.

V. Assistive Listening Systems:
1. Set gain / limiter so that normal speech or music does not over modulate the transmitter.

2. Adjust emitter panels to provide even coverage throughout the courtroom.

W. Notification:
1. Once all the above is complete, the system(s) is (are) ready for inspection. Formally notify the Owner/Consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and equalization will be conducted at the time of inspection.

3.10 CONFERENCE AUDIO TESTS

A. Constant Voltage Speaker test:
1. Provide a low-level distinctive tone to each amplifier input.
2. Systematically turn on each amplifier, one by one, and verify that the correct speaker is being driven. Correct wiring as required for proper operation.
3. Walk the areas covered by the speakers and check for even level volume coverage. Adjust any speakers that are not correct by changing tap values as required for even volume level.

B. Speaker Polarity:
1. Use an electronic polarity checker to test each reinforcement speaker. All speakers should have the same relative polarity.

C. System(s) Gain Adjustment:
1. Adjust each active device to have unity gain from the console output to the input of the amplifiers.
2. With all amplifiers turned off, connect a sine wave and pink noise to an input of the console. Using an RMS voltmeter, adjust the scale to an output between -10 and 0dBu. Once level has been established, it should remain unchanged throughout the testing.

D. Amplifier Level Adjustment 70-volt System:
1. Adjust the level of the 70-volt systems to achieve a volume level appropriate for their location and intended use.
2. After initial amplifier adjustment, walk all areas utilizing the 70-volt systems and check for volume uniformity. If any changes of 3dB or more occur, adjust that specific area or speaker as required for even coverage.

E. Input Verification Test:
1. Using a microphone, portable signal generator, or CD player, send signal from every microphone input to the console. Check every connection location in the facility.
2. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
3. Verify that the receptacle under test appears at the correct position on the patch bay and is operating properly.
4. In a similar manner, check any other inputs or tie lines, as appropriate.

F. Impedance:
1. Measure absolute impedance value of each loudspeaker line at 1000 Hz without the amplifier connected but with all speakers connected. Record the impedance levels versus frequency for each loudspeaker line.
2. Impedance must not be below the rated load impedance of respective amplifier and may be any value equal to or above that.
3. Check the resistance of the lines for loudspeaker, line level, and microphone receptacles with the receptacles opened and shorted. Document and repair any shorts or discontinuities found.

G. Polarity:
1. Verify the polarity of each device in the shop to obtain true polarity throughout the system.

2. Verify and document that polarity is kept throughout the system after wiring from inputs through output devices or receptacles.

H. Gain Structure:
1. Turn off amplifiers and set equalizers and filter controls to flat response. Do not bypass any equalizers or filters.
2. Adjust compressors and limiters to a 1:1 compression ratio and a +10 dBu limiting threshold. Do not bypass these processors.
3. Insert pink noise into the mixer or mixing console and adjust levels to obtain a 0 dBu reading for the mixer or mixing console output. Distribute this output to all systems and subsystems.
4. Adjust the output of line level electronics and signal processors to obtain a 0 dBu output at the output terminals. For equipment with input level controls, adjust the input controls so that input levels peak at -10 dB. For equipment not capable of providing 0 dBu output, adjust to achieve as close to 0 dBu as possible.
5. Turn amplifier gain controls to minimum and turn on the power amplifiers. Adjust the gain controls to achieve a +4 dBu output level for low impedance amplifiers and a +18 dBu output level for high impedance or constant voltage amplifiers.

I. Hum and Noise Level:
1. Without changing the gain, terminate microphone and line level inputs with proper shielded resistors of 150 and 600 ohms respectively.
2. Measure and record overall hum and noise levels for each power amplifier output from each input and with all inputs simultaneously. Hum and noise shall be at least 50 dBA below rated power output levels with amplifier controls set for optimum signal-to-noise, using input from line level and microphone sources.

J. Buzzes and Rattles:
1. Apply a 1 kHz sine wave signal such that a 0 dBu level is obtained on the mixer or mixing console.
2. Sweep loudspeaker systems from 50 Hz to 5 kHz at 6dB below full amplifier power. Listen for buzzes, rattles, vibrations or resonance. Locate and correct problems.
3. If the cause is outside the system, promptly notify the Consultant, indicating the cause and recommended corrections.

K. Coverage:
1. Using pink noise as an input, adjust loudspeakers and output levels to provide ±6 dB coverage in the octave band centered at 1 kHz throughout the areas served by the system.
2. Measure and record results.

L. Equalization:
1. Equalize the sound systems in order to provide uniform response, raise the threshold of feedback, suppress ring modes, and insure natural, pleasing sound in equal and adequate amplitude with maximum degree of intelligibility, and provide performance conforming to the requirements specified under "Acceptance Testing."
2. Using pink noise as an input and with system equalizers set to bypass operation, determine the average frequency response of the loudspeaker system in the room using a 1/3 octave real time analyzer.
3. Record the frequency response derived.
4. Locate the analyzer microphone approximately 1 m above the floor at a point which approximates the average frequency response, within ±3 dB from 50 Hz to 16 kHz.
5. Record the frequency response at this location.
6. Using pink noise as an input and with system equalizers set to normal operation, set low and high pass filters at 63 Hz and 16 kHz respectively.

7. Adjust the 1/3 octave filter settings to obtain the following response curves, minimizing the variation (±3 dB) between adjacent filter settings:
   a. Roll off -6 dB per octave below 125 Hz.
   b. Maintain ±3 dB, 125 Hz to 4 kHz.
   c. Roll off -3 dB per octave from 4 kHz to 12 kHz.
   d. Roll off sharply above 12 kHz.
   e. With any system microphone open, make minor adjustments to maximize gain before feedback. No more than 3 filter settings shall be adjusted.
   f. Record the frequency response derived.

M. System Input and Output Levels
   1. Using pink noise source material and a calibrated ANSI S1.4-1983 (1997) Type 1 or IEC 60651-01-1994, precision sound level meter, perform the following:
      a. For microphone level inputs: locate a pink noise source at a distance of 300 mm from the corresponding system microphone. Adjust the pink noise source to provide a level of 75 dBA at the microphone and set mixer levels to achieve a 0 dBu level at the mixer output.
      b. For line level inputs: use system program source equipment, with pink noise playback media, as a direct input to the mixer or mixing console and set mixer levels to achieve a 0 dBu level at the mixer output. Repeat for each system input individually where mixer inputs vary in input sensitivity. Settings for equivalent sensitivity inputs may be duplicated.
      c. With any input set as specified above, adjust audio distribution amplifiers to provide levels of -10 dBu at each output.
   2. Measure and record results.

N. Feedback Stability:
   1. With required output levels set, measure and record the available gain before feedback. Feedback stability margin shall be 6 dB, minimum.

O. Assistive Listening Systems:
   1. Set gain / limiter so that normal speech or music does not over modulate the transmitter.
   2. Adjust emitter panels to provide even coverage throughout the courtroom.

P. Notification:
   1. Once all the above is complete, the system(s) is (are) ready for inspection. Formally notify the Owner and/or Consultant at least seven (7) days prior to desired inspection date.
   2. Final adjustments and equalization will be conducted at the time of inspection.

3.11 WEB CONFERENCE AUDIO TESTS

A. Constant Voltage Speaker test:
   1. Walk the areas covered by the speakers and check for even level volume coverage. Adjust any speakers that are not correct by changing tap values as required for even volume level.

B. Speaker Polarity:
   1. Use an electronic polarity checker to test each reinforcement speaker. All speakers should have the same relative polarity.

C. System(s) Gain Adjustment:
   1. Adjust each active device to have unity gain from the computer output to the input of the amplifiers.
   2. Adjust each active device to have unity gain from the USB microphone and or interface to the input of the computer.

D. Amplifier Level Adjustment 70-volt System:
   1. Adjust the level of the 70-volt systems to achieve a volume level appropriate for their location and intended use.
   2. After initial amplifier adjustment, walk all areas utilizing the 70-volt systems and check for volume uniformity. If any changes of 3dB or more occur, adjust that specific area or speaker as required for even coverage.

E. Impedance:
   1. Measure absolute impedance value of each loudspeaker line at 1000 Hz without the amplifier connected but with all speakers connected. Record the impedance levels versus frequency for each loudspeaker line.

F. Polarity:
   1. Verify the polarity of each device in the shop to obtain true polarity throughout the system.
   2. Verify and document that polarity is kept throughout the system after wiring from inputs through output devices or receptacles.

G. Gain Structure:
   1. Turn off amplifiers and set equalizers and filter controls to flat response. Do not bypass any equalizers or filters.
   2. Adjust compressors and limiters to a 1:1 compression ratio and a +10 dBu limiting threshold. Do not bypass these processors.
   3. Insert pink noise into the mixer or mixing console and adjust levels to obtain a 0 dBu reading for the mixer or mixing console output. Distribute this output to all systems and subsystems.
   4. Adjust the output of line level electronics and signal processors to obtain a 0 dBu output at the output terminals. For equipment with input level controls, adjust the input controls so that input levels peak at -10 dB. For equipment not capable of providing 0 dBu output, adjust to achieve as close to 0 dBu as possible.
   5. Turn amplifier gain controls to minimum and turn on the power amplifiers. Adjust the gain controls to achieve a +4 dBu output level for low impedance amplifiers and a +18 dBu output level for high impedance or constant voltage amplifiers.

H. Hum and Noise Level:
   1. Verify that the noise floor is sufficiently low and that there is no audible hum in the system.

I. Buzzes and Rattles:
   1. Apply a 1 kHz sine wave signal such that a 0 dBu level is obtained on the mixer or mixing console.
   2. Sweep loudspeaker systems from 50 Hz to 5 kHz at 6dB below full amplifier power. Listen for buzzes, rattles, vibrations or resonance. Locate and correct problems.
   3. If the cause is outside the system, promptly notify the Consultant, indicating the cause and recommended corrections.

J. Coverage:
   1. Using pink noise as an input, adjust loudspeakers and output levels to provide ±6 dB coverage in the octave band centered at 1 kHz throughout the areas served by the system.
   2. Measure and record results.

K. Equalization:
   1. Equalize the sound systems

L. Feedback Stability:
   1. With required output levels set, measure and record the available gain before feedback. Feedback stability margin shall be 6 dB, minimum.

M. Assistive Listening Systems:
   1. Set gain and/or limiter so that normal speech or music does not over modulate the transmitter.
   2. Adjust emitter panels to provide even coverage throughout the courtroom.

N. Notification:
   1. Once all of the above is complete, the system(s) is (are) ready for inspection. Formally notify the Owner and/or Consultant at least seven (7) days prior to desired inspection date.
   2. Final adjustments and equalization will be conducted at the time of inspection.

3.12 GENERAL VIDEO PRESENTATION SYSTEMS

A. Video signals shall be scaled if necessary to provide the native resolution signal to display and or video capture devices.

B. Whenever possible a common native resolution shall be determined for each space and shall be provided to every display in the system.

C. Digital video signals shall be set at a minimum 1920 x 1080 resolution unless otherwise noted.

D. Contractor shall provide an EDID plan indicating native resolutions and any special display and or source type that requires scaling or conversion.

3.13 CAMERA EQUIPMENT:

A. Camera images shall be free of visible vibration and dead pixels.

B. Adjust and set white balance, and color timing, and genlock / sync as required.

C. Adjust pan-tilt limit switches.

D. Provide low voltage power from equipment racks.

E. Provide wall and/or ceiling mounts.

3.14 COMPUTER and/or VIDEO INTERFACES

A. Review all locations with the Owner prior to installation and provide according to Approval of the Owner. Low voltage power shall be provided at the interface as required by the manufacturer.

B. Provide HDMI, Display Port, VGA with audio breakout cables for each input interface provided as specified herein unless noted otherwise.

C. Provide manufacturer's adapter plates for pass-through connections as specified herein unless noted otherwise.

D. Adjust interface as required by manufacturer for EDID and HDCP system compliance.

3.15 SIGNAL PROCESSING EQUIPMENT

A. Signal processing equipment shall be mounted in the equipment racks and/or control consoles, as specified herein unless noted otherwise.

B. Configure and adjust signal processing equipment to produce the native resolution of the primary display devices within each separate system for each potential source resolution, unless specified otherwise herein. RGBHV sources shall be tested from 640 x 480 at 60 Hz through 1600 x 1200 at 60 Hz. SDI, HD-SDI, HDMI, and Display Port shall be tested based on published standards. Legacy NTSC video (composite, component, and s-video) to be tested and configured based on NTSC standards. .

3.16 VIDEO AND DATA PROJECTORS AND ASSOCIATED EQUIPMENT

A. The native resolution of the video switching and or processing system shall be set to match the resolution of the Video and data projector(s).

B. EDID management and scaling shall be used to manage outputs that have a lower resolution equipment than that of the highest resolution display device.

C. Fixed video and data projectors shall be made level and secured to the structure in accordance with seismic requirements of the International Building Code-2000 if applicable.

D. Projector(s) and mounts shall be installed per the manufacturer's written instructions and shop drawings. Review all locations with the Owner's Representative and or Consultant prior to installation.

E. Configure projectors and lens selection(s) to provide full-screen images at the projector's native resolution, unless otherwise specified.

F. If an internal HDBaseT input module is utilized ensure that all required functions and capabilities are provided or if and external HDBaseT receiver will be required to support device connections.

G. Review all locations with the Owner's Representative and or Consultant prior to installation.

3.17 FLAT PANEL MONITORS AND ASSOCIATED EQUIPMENT:

A. The native resolution of the video switching and or processing system shall be set to match the resolution of the monitor. Configure monitors to provide full images at the monitor's native resolution.

B. EDID management and scaling shall be used to manage outputs that have a lower resolution equipment than that of the highest resolution display device.

C. Flat panel monitor(s) shall be made level and secured to the structure in accordance with seismic requirements of the International Building Code-2000 if applicable.

D. Flat panel(s) and mounts shall be installed per the manufacturer's written instructions and shop drawings. Review all locations with the Owner's Representative and or Consultant prior to installation.

E. If an internal HDBaseT input module is utilized ensure that all required functions and capabilities are provided or if and external HDBaseT receiver will be required to support device connections.

F. Review all locations with the Owner's Representative and or Consultant prior to installation.

3.18 VIDEO SYSTEMS

A. General
   1. Adjust, balance, and align equipment for optimum quality and to meet the manufacturer's published specifications.

B. Performance Standards
   1. Unless restricted by the published specifications of a particular piece of equipment, or unless specified otherwise herein, the following performance standards shall be met by each system.

C. Cabling
   1. Upon completion of the installation of each area, the Contractor shall test all elements of the system. This testing shall include as a minimum:
      a. Continuity of all circuits.
      b. Operation of all circuits.
      c. Phase checking of all circuits.

d. Operation of all equipment in all modes

2. During and/or after installation, as appropriate, the Contractor shall test all cabling for continuity, phase, shielding, and unreasonable signal loss. The testing shall be conducted according to the submitted and approved test plan.

3.19 SPARE PARTS

A. Provide replacement fuses, lamps, batteries and connectors in sufficient quantities to last one (1) year.

3.20 CONTRACTOR TESTING AND OR COMMISSIONING

A. Before Acceptance Tests are scheduled, the Contractor shall perform their own system check-out. He shall furnish all required test equipment and shall perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification.

B. The contractor's testing and documentation activities shall conform to ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard or preapproved equal to ensure that the audiovisual systems are complete, tested, and free of operational defects.

C. Supplementary Checklist: http://www.infocomm.org/cps/rde/xbcr/infocomm/CAVSP_Checklist.pdf

D. As a means to facilitate the use of the ANSI/INFOCOM 10:2013 standard we would recommend the use of the software application I-auditor or similar that allows for efficient documentation of checklist items and completion status. http://www.safetyculture.com.au/iAuditor/ https://www.inspectionchecklists.net/template/880F4474-20E8-4CBB-BD09-00332B15E391 The template for ANSI/INFOCOM 10:2013 can be found in the on line library.

E. Testing items:

1. Testing of audiovisual systems shall include the following items as applicable to the systems installed:
   a. Provide documentation that all audio signal connections have been tested and verified.
   b. Provide documentation that all video signal connections have been tested and verified.
   c. Provide documentation that all control signal connections have been tested and verified.
   d. Provide documentation that all mounting and rigging elements have been verified for structural integrity and safety.
   e. Test all audio systems for compliance with the Performance Standards, using the following minimum equipment:
      1) Test Equipment: Assemble the following test equipment (or equivalent) on site.
      2) Audio Test Equipment:
         a) JBL / Harmon SIA-Smaart Pro or approved equal.
         b) Signal generator,
         c) Audio test set,
         d) Audio Phase Checker
      3) Compact Disc
      4) Audio cable(s)
      5) Set of terminations, adapters etc.
      6) Adjustments verification and gain settings:
         a) Test and adjust all systems (starting at source equipment and terminating at the power amplifiers and speakers as appropriate) for correct gain structure providing low noise and distortion per manufacturers' published specifications.

f. Test all video systems for compliance with the Performance Standards, using the following minimum equipment:
   1) Video Test Equipment:
      a) SDI, HD-SDI video signal generator.
      b) DVI, HDMI video signal generator.
      c) RGB / VGA video signal generator.
   2) RGB cable, (if RGB and/or VGA is included in design)
   3) HDM, DVI, Display Port, Video cables
   4) Set of terminations, 'T' pieces etc.
   5) Adjustments, configuration, and verification:
      a) Test and adjust all systems (starting at source equipment input(s) and terminating at the display(s) checking for compatible display resolutions, EDID and HDCP compliance.

3.21 CONSULTANT ACCEPTANCE TESTS

A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined within section 3.20 has been completed and the test results have been received and reviewed by the consultant and or owner.

B. Consultant acceptance testing will be conducted based on applicable sections of the ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard.

C. Checklist items within this list will be verified by visual and or audible methods as part of normal room use case operational scenarios, with the assumption that the AV contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per section 3.17 above.

D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
   1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
   2. The operation of all system equipment shall be demonstrated by the contractor.
   3. Contractor shall provide a laptop to support testing activities that is configured and connected to any and all DSP processors for any evaluation and adjustments (tuning) activities by the consultant.
   4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection and/or configuration.
   5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
   6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
   7. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the consultant.

E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION

SECTION 27 53 13

CLOCK AND BELL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide and install complete and operational Audiovisual System(s) as outlined in these specifications and related drawings and documentation requirements as set forth in this documentation.
   2. It is the responsibility of the Contractor to provide all wiring, plates, connections, equipment, rigging, all support means and miscellaneous equipment for complete and fully operational System(s) if specified in this or other related documents or not.

B. Provide for the coordination, provision, installation, inspection, testing, instruction, and warranties of the Clock and Bell System(s).

C. Provide all materials, equipment, transportation, and necessary labor for a complete and operational Clock and Bell System(s).

D. Additional contractor requirements:
   1. Required licenses, permits and low voltage permits including any required bonding or insurance requirements to comply with general conditions of specifications and contract documentation.
   2. Verification of the dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturers' recommendations.
   4. Submittal information and provisions.
   5. Documented Clock and Bell System(s) testing procedures.
   6. Instruction of operating personnel.
   7. Manuals and provisions thereof.
   8. Maintenance and warranties.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including, but not limited to, Divisions 0, 1, 11, 26, 27 and the general contract specifications.

B. Related specification sections:
   1. Section 26 05 33.10 – Raceway and Boxes for Audiovisual Systems

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are not limited to:
   1. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   2. Section 26 05 29 – Hangers and Supports for Electrical Systems
   3. Section 26 05 33 – Raceway and Boxes for Electrical Systems
   4. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.5 DEFINITIONS:

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
   2. The terms "shall" is mandatory, "will" is informative, and "should" is advisory.
   3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
   4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
   5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
   6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
   7. The term "Professional grade" – Equipment that is intended for commercial use, not residential, use and is rated for continuous 24-7 use.
   8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
   9. The term "Labels" – refer to labels on audio-visual equipment as outlined in Section 3.4.
   10. The term "OFE" refers to items that are Owner Furnished Equipment
   11. The term "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
      a. International Building Code / BOCA National Building Code
      b. Local Governing Authorities Having Jurisdiction
      c. NFPA-72 National Fire Alarm and Signaling Code
      d. NFPA-70 National Electric Code (NEC)
      e. UL Listed- Underwriter's Laboratories Listed
   2. IEC 60268-16 Third Edition 2003-05 Objective rating of speech intelligibility by speech transmission index
   3. AES:
      a. AES3-1-2009 (r2014): AES standard for digital audio
      b. AES5-2008 (r2013): AES recommended practice for professional digital audio

c. AES10-2008 (r2014): AES Recommended Practice for Digital Audio Engineering
d. AES14-1992 (s2014): AES standard for professional audio equipment
e. AES31-2-2012: AES standard on network and file transfer of audio - Audio-file transfer and exchange
f. AES47-Am1-2008: Amendment 1 to AES47 - AES standard for digital audio - Digital input-output interfacing - Transmission of digital audio over asynchronous transfer mode (ATM) networks
g. AES50-2011: AES standard for digital audio engineering - High-resolution multi-channel audio interconnection
h. AES54-2-2008 (r2013): AES standard on interconnections - Grounding and EMC practices - Shields of balanced audio wiring within fixed and portable passive connector panels, jack fields, and passive microphone splitters
i. AES54-3-2008 (r2013): AES standard on interconnections - Grounding and EMC practices - Shields of balanced microphone-level outputs of active equipment other than microphones
j. AES67-2015, methods for high-performance streaming audio-over-IP network interoperability.
k. AES70-1-2015: AES standard for audio applications of networks - Open Control Architecture - Part 1: Framework
l. AES70-2-2015: AES standard for audio applications of networks - Open Control Architecture - Part 2: Class structure
m. AES70-3-2015: AES standard for audio applications of networks - Open Control Architecture - Part 3: Protocol for TCP/IP Networks

4. ANSI/ INFOCOMM:
   a. 1M:2009 Audio Coverage Uniformity
   b. 2M:2010 Standard Guide for Audiovisual Systems
   c. 10:2013 Audiovisual Systems Performance Verification
5. ANSI / TIA / EIA:
   a. TIA-222 STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS
   b. TIA-455-78 Revision B, FOTP-78 IEC 60793-1-40 Optical Fibers - Part 1-40: Measurement Methods and Test Procedures – Attenuation
   c. TIA 568-B.1-2000 Telecommunications Standard
   d. TIA-568-C.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS
   e. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
   f. TIA / EIA: 606a Telecommunications Infrastructure Standard
   g. TIA / EIA: 607 Grounding and Bonding Requirements
   h. EIA/CEA: 861 A DTV Profile for Uncompressed High-Speed Digital Interfaces.
   i. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History
   j. EIA 232-D Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Serial Binary Data
   k. EIA RS-310-C Racks, Panel, and Associated Equipment
6. FIBER OPTIC REFERENCE PUBLICATIONS
   a. Refer to the fiber optic cable manufacturers design guide: i.e. SIECOR
      1) Siecor Universal Transport System (UTS) Design Guide, Siecor Corp., 1988 Brochure #CC-110

b. Also refer to the following standards committees:
1) ANSI: (IEEE) 802.8 Proposed Fiber Distributed Data Interface

1.7 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide Clock and Bell System(s) compatible with the Owner's communications systems (i.e. telephone and computer systems) and operations.

B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.

C. The Contractor shall provide complete and operational system(s) configured and installed for user-friendly operation and low maintenance.
1. Provide for reprogramming of the remote control software two (2) times, as directed by the Owner's Representative and or Consultant.
2. Provide for two (2) level adjustments of the Clock and Bell System(s), as directed by the Owner's Representative and or Consultant.

D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.

E. The Contractor shall restore all finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.

F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.

G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.

H. All finalized software affiliated with the equipment, including but not limited to, the Clock System, Bell and Paging System(s), and Control software, etc. is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.

I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, all passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM(S) DESCRIPTION AND REQUIREMENTS

A. The following is a basic system(s) description and is not intended to be all-inclusive for proper installation or operation of system(s). The Clock and Bell specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.
1. The Bid proposal will include all labor and cabling for all optional / add alternate equipment listed in specification and Bid set drawings. Please list as separate budgetary items.

1.9 RELATED WORK

A. Conduits:

1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.

B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

C. The Contractor shall, without cost to the Owner/Consultant, replace any products damaged during storage, handling, or during installation

1.11 SCHEDULING

A. The Contractor shall submit a schedule to the Owner/Consultant for approval within 10 (ten) working days from notice to proceed. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off. This schedule shall be submitted in Microsoft Project (or similar program) in both paper and electronic format, with submittals.

B. It is the responsibility of the Contractor to coordinate the installation of the system(s) to be compatible with the work of the other trades. The Contractor shall attend progress meetings and provide continuous on-site project management.

C. It is the responsibility of the Contractor to arrange with the Owner/Consultant a mutually acceptable time and date(s) for Acceptance Testing, based upon project dates and schedule provided, based upon the dates provided in the Solicitation.

D. The Contractor shall provide operating personnel with extensive training for each system type and/or room type as outlined in Section 1.8 SYSTEM(S) DESCRIPTION AND REQUIREMENTS.

1.12 PROJECT SCHEDULE

A. A (mandatory) pre-bid site visit on, DATE at TIME will be utilized to allow the Contractor to review the current jobsite conditions and define special requirements.

B. All Requests For Information (RFI) shall be directed to the Consultant and should be received by Close of Business (COB) on DATE.

C. All bids must be received at the Warrenton office of Polysonics to the attention of the Consultant. All bid proposals (electronic copy) are due to Polysonics no later than TIME on DATE.

D. Hard copies of the bid proposals will be accepted by COB on September 12th.
   1. Please submit three hard copies.

E. The opening of the bid proposals will be held between Polysonics and the Owner, with no bidder's present.

1.13 BID/TECHNICAL PROPOSALS

A. The Contractor shall be experienced in the provision of systems similar in complexity to those required for this project and Contractor shall provide documentation demonstrating the below minimum criteria:
   1. The primary business of the Contractor/Installer shall be the installation of Audio or Clock and Bell systems.
   2. At least three (3) years' experience with the specified equipment and systems.
   3. Experience with at least one project of similar size and complexity as outline in these specifications.
   4. Be an authorized dealer and service facility for the products specified and furnished.
   5. Maintain a technically trained installation crew and service crew for maintenance and installation of the specified system(s).
   6. Lead Installer shall have attended factory training for equipment specified in this specification.
   7. Contractor shall demonstrate that the installation staff consists of 50% CTS-I trained personnel and have at least one (1) CTS-D on staff.
   8. Final Clock and Bell System(s) configurations shall be approved by the Owner's Representative, Architect and Consultant.
   9. Upon request of the Owner/Consultant, Contractor shall demonstrate that he has:
   10. Sufficient facilities and equipment for this work.
   11. Sufficient staff with the appropriate technical expertise and experience for this project.
   12. All Bid proposals shall be valid for ninety (90) days from date received.
   13. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment.

B. Provide a list of five (5) references with locations, names of contacts, and contact phone and email information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old and be of similar size, type, and complexity as the system set forth.

C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents and drawings, manufacturer requirements, and RFI responses as applicable.

1.14 PRE-BUILD AND FINAL SUBMITTALS

A. Provide the following for approval no later than thirty (30) days after Notice to Proceed and prior to commencement of work:
   1. A complete list of all products incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
   2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
   3. All shop drawings defined as required.

B. Shop Drawings:
   1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of system(s).
   2. Shall be scaled appropriately but not less than 1/8" =1'.

3. Shall show detailed schematic wiring diagrams showing interconnection of Contractor-provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
4. Shall show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling.
5. Shall show all A.C. power outlet locations and terminal strip locations within each equipment rack including all sequencing as required for proper start-up and shut down.
6. Shall show plans and sections of the building and adjacent grounds with the location of all installed equipment such as loudspeakers, racks, consoles, plates/panels, antennas, (etc.).
7. Shall show patch panel layouts and labeling strips, including color schemes, as necessary.
8. Shall show full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
9. Shall show all speaker mounting details including hardware types and load capacity.
10. Shall provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate and sample plates per type.
11. Shall show complete labeling schemes for all cabling and equipment components for project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
12. Shall show a complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout coordination information.

C. Submittal Format: (PDF version)
1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
2. Separate major groupings Use multiple volumes / list of content
3. Index product data sheets by manufacturer and model or part number.
4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
5. Reference addendum or change order numbers as applicable.
6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
7. Provide via pdf, posted to FTP, thumb drive and or CD / DVD ROM.
8. Each submittal shall include a complete table of contents with the following information:
    a. Project title and number.
    b. Submittal number.
    c. Date of submission.

D. Submittal Format: (Printed Option if Required)
1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
6. Reference addendum or change order numbers as applicable.

7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

1.15 PROJECT CONDITIONS

A. Verify conditions on the job site applicable to this work. Notify Owner's Representative / Consultant in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.16 QUALITY ASSURANCE

A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.

B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating clock and bell equipment and services. Manufacture shall be able to provide references of similar installations rendering satisfactory service.

C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.
   1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.
   2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
   3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.17 PRE-INSTALLATION MEETING/SCHEDULE

A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.

1.18 FINAL INSPECTION AND TESTING / COMMISSIONING

A. Upon completion of installation and Contractor testing and commissioning (as outlined in sections 3.8 - 3.20), the Consultant shall perform system(s) inspection and testing (as outlined in section 3.21).

B. To assist the Consultant, the Contractor shall provide a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the specified system(s).

C. The process of testing the system(s) may necessitate moving and/or adjusting certain components such as speaker aiming, transformer tap values, software adjustments, and control adjustments.

D. Testing will include operation of each system and all components. The Contractor will provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.

E. In the event that adjustments or work is required during testing, or to bring the systems into specification, the Contractor shall continue his work until the system(s) are acceptable with no addition to the contract price. If approval is delayed due to defective equipment, and/or failure of equipment or installation that meets the requirements of this specification, the Contractor shall pay for additional time and expenses to the Owner at the rate specified by the Owner.

F. All Control Systems shall be fully tested prior to commissioning. Once the Control Programming is finalized all source code, and programming, shall be burned on to a CD ROM or thumb drive, and delivered to the Owner. All Control System programming (including source, files,), and DSP files shall become the property of the Owner.

G. Digital Audio Processors shall be fully programmed and tested prior to commissioning. Once the programming is "finalized" and accepted all presets and configurations shall be stored on a USB drive and burned onto a CD ROM and delivered to the Owner.

1.19 WARRANTY

A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial two-year service contract.

B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.

C. The Contractor shall respond with a remedy to a trouble call within twenty-four (24) hours upon receipt of such a call and shall provide a 24-hour service phone number. Downtime for system(s) shall be no longer than a 24-hour period. All replacement parts/components shall be of equal or higher level of service.

D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

E. At least two routine inspections and adjustment visits shall be scheduled for the first year, coordinated with Owner's Representative.

F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.

G. The Contractor shall be present at the first use of the system (scheduled by the Owner), and one (1) additional event as requested by the Owner for no additional charge.

1.20 INSTRUCTION OF OWNER PERSONNEL

A. After final inspection and completion, provide instruction to Owner-designated personnel on the operation and maintenance of the system(s).

B. A training program shall be designed to provide a comprehensive understanding and basic level of competence with the system. It shall be sufficiently detailed to allow Owner personnel to operate the system independent of any outside help.

C. The training plan or class shall include detailed sections outlines and related reference materials. The Owner personnel shall be able to utilize these materials in the subsequent training of their co-workers.

D. Submit an outline of the course with sample instructional aids for approval one (1) week prior to scheduled instruction sessions.

E. The training time shall not be less than a total of 32 hours, and shall consist of:
   1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
   2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
   3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's telecommunications personnel

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electronic component models shall be commercially available for a least one (1) year prior to bid or be approved by the Consultant and or Owner's Representative.

B. All equipment and material shall be new unless otherwise noted in this specification or on drawings.

C. All equipment must be UL listed or built to UL standards, where required.

2.2 GENERAL

A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied, unless a variance (exemption document) is submitted and approved by the Consultant.

B. System(s) shall be installed and configured for simplicity of operation, with user-friendly controls.

C. Provide product quantity as required for complete and operable system(s). If any quantities are given, the Contractor shall provide at least the given amount. Some of the products listed under this section may not be required to fulfill the work as outlined.

D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.

E. Remove all manufacturer's nameplates or logos from product, such as found on speaker(s), within the public sight lines or spaces when applicable.

F. Paint all wall and ceiling mounted speaker grilles and enclosures as directed by the Consultant/Architect.

G. The Contractor is responsible for providing a fully operational turnkey Clock and Bell systems. The following equipment list and attached drawings are for final design intent purposes.

H. Equipment

I. Paging Head End System
1. Provide a fully functioning head end system
2. Provide with all necessary cards and cables
3. Provide with all necessary power supplies
4. Provide with properly sized auxiliary amplifier(s)
5. Provide with all control hard ware and software
6. Provide with necessary digital signal processor (DSP) equipment
7. Provide with speaker and line monitoring equipment
8. Provide with rack mounting equipment
9. Acceptable Product:
    a. Audio Enhancement MS-250 (provide 12), Biamp TesiraFORTE AVB A1, Lab Gruppen C48.4 (provide 3), Audio Enhancement EPIC System Server Kit 3500-0500-0500 (Kit includes: (2) 1300-1215, (1) Microphone 1300-1688, Map software 1300-2110, 22" touch monitor 2000-0591, keyboard 2000-0591, processor 3500-0463, Server AAAQ104210, EPIC 3500-0470, EPIC 3500-0471, Virtual remote 3500-0475, hardware 4500-0042, hardware 4500-0174, Manual 4700-0020, Admin manual 4700-0026, flash drive 4700-0027)

J. Clock Software Configurator:
1. Clock setup software configurator
2. Acceptable Product:
    a. American Time network Clock Connect

K. Analog Clock (CK1) (one sided)
1. Power over Ethernet (PoE) technology derives power and synchronized time updates from your existing network
2. Automatic Daylight Saving Time adjustments
3. No master clock or serial connection required
4. 12" clock
5. Heavy-duty black steel case with convex glass crystal
6. Buzzer sound level of 65 dBA at 10 ft.
7. Acceptable product:
    a. American Time PES4BHPD904-WEB or approved equal

L. Analog Clock (two sided)
1. Power over Ethernet (PoE) technology derives power and synchronized time updates from your existing network
2. Double Side Face
3. 12" clock
4. Automatic Daylight Saving Time adjustments
5. No master clock or serial connection required
6. Heavy-duty black steel case with convex glass crystal
7. Buzzer sound level of 65 dBA at 10 ft.
8. Acceptable product:
    a. American Time PES48HPD904-WEB or approved equal

M. Analog Clock (CK3)

1. Power over Ethernet (PoE) technology derives power and synchronized time updates from your existing network
2. Protective Face
3. 15" clock
4. Automatic Daylight Saving Time adjustments
5. No master clock or serial connection required
6. Heavy-duty black steel case with convex glass crystal
7. Buzzer sound level of 65 dBA at 10 ft.
8. Acceptable product:
    a. American Time PE63BHPD204-WEB or approved equal

N. CALL SWITCHES
1. Black momentary push button to initiate call
2. Heavy-duty long-life switches
3. Standard single gang Decora style wall plate
4. Call-in from classrooms or other staff locations
5. Acceptable Product:
    a. Audio Enhancement WPA-04

O. Clock Bell Ceiling Speakers (with Tile Bridge)
1. Program Material: Paging and background music
2. Installation: Hard ceiling, blind mount
3. Average Sensitivity: 92 dB SPL, 1W/ 1M
4. Loudspeaker Power Rating: 20W RMS, EIA 426A Standard
5. Calculated Output: 104 dB SPL, 5W/ 1M
6. Magnet Type & Weight: BeFe Ceramic, 10 oz. Nominal
7. Frequency Response: 60Hz - 17kHz EIA 426A Standard
8. Nominal Coverage Angle: 90° Included Angle, -6 dB / 2 kHz, Half space
9. Audio Connection: 7" Color-Coded Pigtails, Pre-Cut
10. Electrical Access: 1/2" Side Mounted, Flexible Conduit Clamp
11. Acceptable product:
    a. Quam System 21or approved equal

P. Equipment Racks:
1. Fully gang-able racks with locking rear doors
2. 31.5" overall depth, 29" useable depth
3. Locate racks as shown on drawings
4. Racks shall be 70" useable space or as shown on drawings
5. Provide with appropriate side panels as required
6. Provide with proper ventilation for proper equipment cooling
7. provide fans and control
8. Provide vent panels
9. All empty rack spaces to be filled with blank panels
10. Provide with one rack work light per every two racks
11. Provide with vertical Lacing strips for clean cable installation
12. Provide with horizontal lace bars when necessary
13. Provide with "Z" clip when necessary
14. Provide with vented locking front door as appropriate
15. Provide with caster base when standalone rack utilized
16. Provide quantity as required as per section 3.02 and shown on drawings
17. Supply black in color
18. Acceptable Product:

a. Middle Atlantic BGR 4538 with SurgeX SX1120RT(as required), APC SUA50UPS

2.3 PLATES AND PANELS

A. Provide plates and panels as described/detailed in the drawings and as required for fully operable system(s).

B. Custom plates shall be 1/8" thick aluminum, standard EIA sizes, sized to cover rough- in/boxes behind plates.

C. Plastic plates are not allowed or accepted.

D. Lettering shall be in all caps and numbers engraved with black or white lettering to the base material with a minimum size of 0.25".
   1. Font Size shall be 1/8"
      a. Font Style shall be Helvetica

E. Acceptable manufacturer of custom plates and panels shall be:
   1. RCI Custom – AL/ALOS series Aluminum Wall Plates
      a. Provide AL series Aluminum Plates for floor and in wall box assemblies.
      b. Provide ALOS series Aluminum Plates for wall boxes.
      c. Or approved equal

2.4 PROPOSED SUBSTITUTIONS

A. Where specific equipment is described, it is not the intention to discriminate against the products of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.

B. The Owner's Representative and or Consultant requires manufacturer's original specification tests. The Owner's Representative and or Consultant will evaluate and approve/disapprove all substitutions.

C. Items designated "no substitutions" shall be that specified item only. Submission of items other than specified shall not be considered and may disqualify RFP submission.

2.5 CABLES AND WIRING

A. All audio cable shall be stranded copper conductors.

B. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

C. Plenum Rated / Non-Plenum Ratings: Cable routed in conduits and or equipment racks can have non-plenum rated (PVC) jacket. All other cables shall have a plenum or riser rated jacket compliant to the cable run and purpose. Cable runs shall be continuous without splices.

D. Cable Selection: Based on signal type as indicated on single line diagram, noted at equipment input, or output connection type. Wire manufacturer and part numbers are provided as a basis of cable quality and signal characteristics. Alternate cable manufacturers to be requested for approval during pre-build submittal.

E. Cable Types:
   1. Microphone and Line Cable:
      a. Configuration: Twisted pair, 22 AWG West Penn 291 plenum 25291
   2. Low Impedance Loudspeaker Cable: (Select gage based on cable run and wattage)

a. Configuration: Twisted pair, 8 AWG West Penn C208
b. Configuration: Twisted pair, 10 AWG West Penn C210 plenum 25210
c. Configuration: Twisted pair, 12 AWG West Penn C227 plenum 25227
d. Configuration: Twisted pair, 14 AWG West Penn C226 plenum 25226

3. High Impedance Loudspeaker Cable (25V / 100V) (Select gage based on cable run and wattage)
   a. Configuration: Twisted pair, 14 AWG West Penn C226 plenum 25226
   b. Configuration: Twisted pair, 16 AWG West Penn C225 plenum 25225
   c. Configuration: Twisted pair, 18 AWG West Penn C224 plenum 25224
4. Wireless Microphone Antenna Cables with-in equipment racks: (Select type based on cable length an signal loss)
   a. Configuration: RG-58/U solid center conductor West Penn 812 plenum 25812
5. Wireless Microphone and Hearing Assistance Antenna Cables outside of equipment racks
   a. Configuration: RG-8/U solid center conductor West Penn 98G8 plenum 2598G8
6. Network Cable for audio streaming transport.
   a. Unshielded Twisted pair Category 5e Cabling West Penn Wire 254245
   b. F/UTP Category 6 Cabling West Penn Wire 254246AF
7. RS-232 Control Cable
   a. Configuration: Twisted pair, 22 AWG West Penn 291 plenum 25291
   b. 9-conductor 22AWG. Communications cable: Belden 9945.
   c. 9-conductor 18AWG. Communications cable: Belden 83659.
8. Cable manufacturer recommendations:
   a. West Penn Wire and Cable
   b. Belden
   c. Substitution: By approved substitution means.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing.

B. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.

C. Units shall be installed parallel and square to building lines. All wires shall be gathered and fastened to create an orderly installation.

D. Electronic equipment shall be permanently mounted in equipment racks or as applicable to the equipment and application.

E. Contractor shall follow all applicable ANSI / INFOCOMM standards as a basis of design, fabrication, construction, and Performance Verification.

F. Provide shaft locks or security covers on non-user operated equipment having front panel access.

G. Install XLR-type connectors wired as follows: Pin 2 High, Pin 3 Low, and Pin 1 Shield.

H. Mount all equipment, speakers, plates and panels, plumb and level.

I. Permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.

J. Contractor shall validate bracing or blocking for proper mounting and safety.

K. Contractor shall provide seismic bracing for appropriate equipment where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 EQUIPMENT HOUSING

A. Equipment Enclosures / Racks:
1. Install all audiovisual equipment within equipment racks according to manufacturer's recommendations and product application.
2. Provide adequate ventilation, thermal management and temperature controlled fans to maintain a rack temperature of less than 85 degrees Fahrenheit.
3. Provide rear support and rear rack rails for housing mounted equipment greater than 15" deep.
4. Allow a minimum of 20% open rack space to support future expansion.
5. Fill all empty spaces with blank panels, sizing as required; painted and or anodized to match housing.
6. Locate operator useable equipment and patch panels at an appropriate operating height.
7. Key all door locks for each housing type (front, rear) alike.
8. Looking at the equipment racks from the rear of the racks, install all AC power and ground cabling on the left and audio and video cabling on the right.
9. Provide LED lights mounted in the top of every two racks to illuminate the interior for service or maintenance. LED lights shall be individually switch-able and placed so as to provide maximum illumination throughout the rack.
10. Dress all loose cabling for a clean and orderly rack. The use of electrical tape for cable management is prohibited.
11. The use of tie wraps for network UTP, STP, and optical fiber cabling is prohibited.
12. Provide nylon braded sleeving for wiring harnesses for a clean installation of cabling that is visible to user areas. Sleeving color shall be coordinated with location and device color.

3.3 PATCH PANELS

A. Audio Patch panel configuration:
1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tie-lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any console connections and interconnection of rooms and equipment.

B. Video Patch Panel Configuration:
1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.

4. Locate sends and tie-lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any device connections and interconnection of rooms and equipment.

C. Unshielded Twisted Pair UTP / STP RJ-45 Patch Panel Configuration:
1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Configure and terminate patch bay per TIA / EIA standards.

3.4 LABELING

A. Device Labeling:
1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

B. Rack Labeling:
1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
2. All rack panel labeling shall be engraved and filled.

C. Wire and terminal strip labeling:
1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
4. Wiring designator shall be alphanumeric code, unique for each cable.
5. Each cable type shall be labeled starting with different destinations (i.e. mic series "Mxxx", speaker series "Sxxx", etc.).
6. On projects that have multi room connectivity the source and destination room numbers should be the prefix for the cable number indicting a cable that traverses between two rooms.
7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.5 OUTDOOR EQUIPMENT MOUNTING

A. Outdoor Mounting Requirements:
1. All outdoor mounting hardware shall be non-corrosive.
2. Any exposed structural supports for speakers or other outdoor components shall be non-corrosive or covered with an inhibiting layer.
3. Any components mounted outside shall be secured in such a way as to prevent movement caused by wind or storms.

4. All speaker, microphone, line, and communications enclosures to include grill components capable of protecting the devices and keep the water and elements out of the components.
5. Seal all connections on each speaker with a waterproof silicone sealant.
6. Provide screened covering over all openings in horn type enclosures to keep out birds, insects, or small animals.

3.6 PERFORMANCE STANDARDS

A. Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise required under the Detailed Specifications, the following performance standards shall be met within each system:
   1. Audio
      a. Frequency Response
         1) Within plus or minus 0.5dB, 20 Hz to 20,000 Hz.
   2. Signal to Noise Ratio
         1) greater than 90dB (including crosstalk and hum at all input/output levels)
   3. Total Harmonic Distortion
         1) 0.05% maximum from 20 Hz to 20,000 Hz.
      b. Microphone (Nominal): -50dbu
         1) Overload (Minimum gain): -5dbu
         2) Maximum Gain: -26dbu
      c. Line (Nominal): +4dbu (-10dbu RCA connections)
         1) Overload (Minimum gain): +24bu
         2) Maximum Gain: +9dbu
      d. Universal Serial Bus (USB) Transport
      e. USB over unshielded twisted pair (UTP) active extender
            a) Extends USB components from processor using a single or dual UTP cable.
            b) Maximum of 330' (100M)
            c) Shall support USB 3.0, 2.0, 1.1, and 1.0 devices with data transfer rates up to 480 Mbps Authentication Protocol WPA2-PSK
            d) USB host support xHCI (USB 3.0), EHCI (USB 2.0), OHCI/UHCI (USB 1.1)
            e) USB data rates Low speed (1.5 Mbps), full speed (12 Mbps), high speed (480 Mbps)
      f. Networked based audio transport and recording protocols
         1) Network based audio streaming and recording standards are constantly being updated and improved and as such this section references specific standards and their current features / capabilities.
      g. Voice over IP (VoIP) telephone
            a) Based on the H.323 Standard as well collaborative protocols to include:
            b) Media Gateway Control Protocol (MGCP)
            c) Session Initiation Protocol (SIP)
            d) H.248 (also known as Media Gateway Control (Megaco))
            e) Real-time Transport Protocol (RTP)
            f) Real-time Transport Control Protocol (RTCP)
            g) Secure Real-time Transport Protocol (SRTP)
            h) Session Description Protocol (SDP)

i) Inter-Asterisk eXchange (IAX)
j) Jingle XMPP VoIP extensions
k) Skype protocol
l) Teamspeak
m) Manufacture specific code for SIP interfaces differ so if differing manufactures are used within a VoIP phone system then care must be taken to ensure that needed functions are intercomparable between manufactures.

h. Control System User Interface

1) Control system user interfaces pages shall be designed for this project exclusively. While there are a great number of design approaches to designing the user interface, the following guidelines shall be adhered to:

a) Provide user and technical control functions and pages for all touch panels as well as for web controls.
b) Control functionality shall be arranged in an intuitive fashion based on specific room uses and device functions. A separate password protected logon would provide technical support access that would include all device specific functions and commands.
c) All panels are to have the time and date as icons, in the same position on every page.
d) All panels are to have a title, indicating the piece of equipment and/or functionality being controlled.
e) Each individual room type shall be given the same user interface design and layout, throughout the entire campus, to the greatest extent practicable.
f) User interface design, shall, to the greatest extent possible – taking into account the variations in system functionality from room type to room type, maintain continuity throughout the campus.
g) Final programming shall include capability to remotely control all functions of the Audio system. Individual device controls shall provide full manufacturer's functionality.
h) Devices similar in nature shall be programmed to operate with a common format.
i) No individual component shall be programmed to function atypically.
j) Whenever the same button appears on more than one page, it will be in the same position on each page.
k) Functions used during a general presentation shall be accessible with a minimal amount of button presses/page flips.
l) Where feasible, multi-level access to controls should be implemented.
m) User help screens shall be included as part of the touch panel designs.

3.7 CONTRACTOR TESTING AND OR COMMISSIONING

A. Prior to energizing or testing the system(s), ensure the following:

1. All products are installed in a proper and safe manner per the manufacturers' instructions.
2. Insulation and shrink tubing are present where required.
3. Dust, debris, solder, splatter, etc. is removed.
4. Cable is dressed, routed, and labels and all connections are consistent with regard to polarity.

5. All labeling has been provided and installed.
6. All products are neat, clean, unmarred and securely fastened.
7. All debris has been cleaned and removed from the site.
8. All electronic devices are properly grounded.

B. Perform the following test. Record all results in the final project manual.
   1. Test each AC power outlet for proper connections for hot, neutral and ground.
   2. Measure and record the DC resistance for the technical ground in the equipment racks and console. Resistance should be 0.15 ohms or less.
   3. Measure the impedance of each speaker line from the amplifier rack.

3.8 PUBLIC ADRESS AUDIO TESTS

A. Constant Voltage Speaker test:
   1. Provide a low level distinctive tone to each amplifier input.
   2. Systematically turn on each amplifier, one by one, and verify that the correct speaker is being driven. Correct wiring as required for proper operation.
   3. Walk the areas covered by the speakers and check for even level volume coverage. Adjust any speakers that are not correct by changing tap values as required for even volume level.

B. Speaker Polarity:
   1. Use an electronic polarity checker to test each reinforcement speaker. All speakers should have the same relative polarity.

C. System(s) Gain Adjustment:
   1. Adjust each active device to have unity gain from the console output to the input of the amplifiers.
   2. With all amplifiers turned off, connect a sine wave and pink noise to an input of the console. Using a RMS voltmeter, adjust the scale to an output between -10 and 0dBu. Once level has been established, it should remain unchanged throughout the testing.

D. Amplifier Level Adjustment 70-volt System:
   1. Adjust the level of the 70 volt systems to achieve a volume level appropriate for their location and intended use.
   2. After initial amplifier adjustment, walk all areas utilizing the 70 volt systems and check for volume uniformity. If any changes of 3dB or more occur, adjust that specific area or speaker as required for even coverage.

E. Input Verification Test:
   1. Using a microphone, portable signal generator, or CD player, send signal from every microphone input to the mixer input. Check every connection location in the facility.
   2. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
   3. Verify that the receptacle under test appears at the correct position on the patch bay and is operating properly.
   4. In a similar manner, check any other inputs or tie lines, as appropriate.
   5. Impedance:
   6. Measure absolute impedance value of each loudspeaker line at 1000 Hz without the amplifier connected but with all speakers connected. Record the impedance levels versus frequency for each loudspeaker line.

7. Impedance must not be below the rated load impedance of respective amplifier and may be any value equal to or above that.
8. Check the resistance of the lines for loudspeaker, line level, and microphone receptacles with the receptacles opened and shorted. Document and repair any shorts or discontinuities found.

F. Polarity:
1. Verify the polarity of each device in the shop to obtain true polarity throughout the system.
2. Verify and document that polarity is kept throughout the system after wiring from inputs through output devices or receptacles.

G. Gain Structure:
1. Turn off amplifiers and set equalizers and filter controls to flat response. Do not bypass any equalizers or filters.
2. Adjust compressors and limiters to a 1:1 compression ratio and a +10 dBu limiting threshold. Do not bypass these processors.
3. Insert pink noise into the mixer or mixing console and adjust levels to obtain a 0 dBu reading for the mixer or mixing console output. Distribute this output to all systems and subsystems.
4. Adjust the output of line level electronics and signal processors to obtain a 0 dBu output at the output terminals. For equipment with input level controls, adjust the input controls so that input levels peak at -10 dB. For equipment not capable of providing 0 dBu output, adjust to achieve as close to 0 dBu as possible.
5. Turn amplifier gain controls to minimum and turn on the power amplifiers. Adjust the gain controls to achieve a +4 dBu output level for low impedance amplifiers and a +18 dBu output level for high impedance or constant voltage amplifiers.

H. Hum and Noise Level:
1. Without changing the gain, terminate microphone and line level inputs with proper shielded resistors of 150 and 600 ohms respectively.
2. Measure and record overall hum and noise levels for each power amplifier output from each input and with all inputs simultaneously. Hum and noise shall be at least 50 dBA below rated power output levels with amplifier controls set for optimum signal-to-noise, using input from line level and microphone sources.

I. Buzzes and Rattles:
1. Apply a 1 kHz sine wave signal such that a 0 dBu level is obtained on the mixer or mixing console.
2. Sweep loudspeaker systems from 50 Hz to 5 kHz at 6dB below full amplifier power. Listen for buzzes, rattles, vibrations or resonance. Locate and correct problems.
3. If the cause is outside the system, promptly notify the Consultant, indicating the cause and recommended corrections.

J. Coverage:
1. Using pink noise as an input, adjust loudspeakers and output levels to provide ±6 dB coverage in the octave band centered at 1 kHz throughout the areas served by the system.
2. Measure and record results.

K. Equalization:
1. Equalize the sound systems in order to provide uniform response, raise the threshold of feedback, suppress ring modes, and insure natural, pleasing sound in equal and adequate amplitude with maximum degree of intelligibility, and provide performance conforming to the requirements specified under "Acceptance Testing."
2. Using pink noise as an input and with system equalizers set to bypass operation, determine the average frequency response of the loudspeaker system in the room using a 1/3 octave real time analyzer.
3. Record the frequency response derived.
4. Locate the analyzer microphone approximately 1 m above the floor at a point which approximates the average frequency response, within ±3 dB from 50 Hz to 16 kHz.
5. Record the frequency response at this location.
6. Using pink noise as an input and with system equalizers set to normal operation, set low and high pass filters at 63 Hz and 16 kHz respectively.
7. Adjust the 1/3 octave filter settings to obtain the following response curves, minimizing the variation (±3 dB) between adjacent filter settings:
   a. Roll off -6 dB per octave below 125 Hz.
   b. Maintain ±3 dB, 125 Hz to 4 kHz.
   c. Roll off -3 dB per octave from 4 kHz to 12 kHz.
   d. Roll off sharply above 12 kHz.
   e. With any system microphone open, make minor adjustments to maximize gain before feedback. No more than 3 filter settings shall be adjusted.
   f. Record the frequency response derived.

L. System Input and Output Levels
1. Using pink noise source material and a calibrated ANSI S1.4-1983 (1997) Type 1 or IEC 60651-01-1994, precision sound level meter, perform the following:
   a. For microphone level inputs: locate a pink noise source at a distance of 300 mm from the corresponding system microphone. Adjust the pink noise source to provide a level of 75 dBA at the microphone and set mixer levels to achieve a 0 dBu level at the mixer output.
   b. For line level inputs: use system program source equipment, with pink noise playback media, as a direct input to the mixer or mixing console and set mixer levels to achieve a 0 dBu level at the mixer output. Repeat for each system input individually where mixer inputs vary in input sensitivity. Settings for equivalent sensitivity inputs may be duplicated.
   c. With any input set as specified above, adjust audio distribution amplifiers to provide levels of -10 dBu at each output.
2. Measure and record results.

M. Feedback Stability:
1. With required output levels set, measure and record the available gain before feedback. Feedback stability margin shall be 6 dB, minimum.

N. Notification:
1. Once all of the above is complete, the system(s) is (are) ready for inspection. Formally notify the Owner/Consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and equalization will be conducted at the time of inspection.

3.9 SPARE PARTS

A. Provide replacement fuses, lamps, batteries and connectors in sufficient quantities to last one (1) year.

3.10 CONTRACTOR TESTING AND OR COMISSIONING

A. Before Acceptance Tests are scheduled, the Contractor shall perform their own system check-out. He shall furnish all required test equipment and shall perform all work necessary to determine and / or modify performance of the system to meet the requirements of this specification.

B. The contractor's testing and documentation activities shall conform to ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard or preapproved equal to ensure that the audiovisual systems are complete, tested, and free of operational defects.

C. Supplementary Checklist:
   1. http://www.infocomm.org/cps/rde/xbcr/infocomm/CAVSP_Checklist.pdf

D. As a means to facilitate the use of the ANSI/INFOCOM 10:2013 standard we would recommend the use of the software application I-auditor or similar that allows for efficient documentation of checklist items and completion status. Which can be found in the on-line library.
   1. http://www.safetyculture.com.au/iAuditor/
   2. https://www.inspectionchecklists.net/template/880F4474-20E8-4CBB-BD09-00332B15E391 The template for ANSI/INFOCOM 10:2013

E. Testing items:
   1. Testing of clock and bell systems shall include the following items as applicable to the systems installed:
      a. Provide documentation that all audio signal connections have been tested and verified.
      b. Provide documentation that all control signal connections have been tested and verified.
      c. Test all audio systems for compliance with the Performance Standards, using the following minimum equipment:
         1) Test Equipment: Assemble the following test equipment (or equivalent) on site.
         2) Audio Test Equipment:
            a) JBL / Harmon SIA-Smaart Pro or approved equal.
            b) Signal generator,
            c) Audio test set,
            d) Audio Phase Checker
         3) Compact Disc
         4) Audio cable(s)
         5) Set of terminations, adapters etc.
         6) Adjustments verification and gain settings:
            a) Test and adjust all systems (starting at source equipment and terminating at the power amplifiers and speakers as appropriate) for correct gain structure providing low noise and distortion per manufacturers' published specifications.

3.11 CONSULTANT ACCEPTANCE TESTS

A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined within section 3.20 has been completed and the test results have been received and reviewed by the consultant and or owner.

B. Consultant acceptance testing will be conducted based on applicable sections of the ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard.

C. Checklist items within this list will be verified by visual and or audible methods as part of normal room use case operational scenarios, with the assumption that the Clock and Bell contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per above.

D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
   1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
   2. The operation of all system equipment shall be demonstrated by the contractor.
   3. Contractor shall provide a laptop to support testing activities that is configured and connected to any and all DSP processors for any evaluation and adjustments (tuning) activities by the consultant.
   4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection / configuration.
   5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
   6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
   7. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the consultant.

E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION

SECTION 28 05 28 - CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide and install boxes, conduits, pathway with pull strings per this document and the companion drawing package.

B. Additional contractor requirements:
   1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
   2. Verification of dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the authority having jurisdiction.
   4. Submittal information and provisions.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including Divisions 0, 1, 15, 26, 28, and the general contract specifications.

B. Related specification sections:
   1. Section 28 13 00 ALARM & ACCESS CONTROL
   2. Section 28 23 00 VIDEO SURVEILLANCE & CLOSED-CIRCUIT TELEVISION

1.4 RELATED WORK

A. The Contractor shall coordinate raceway / junction box locations for future equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
   1. Section 07 84 00 - Firestopping
   2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   3. Section 26 05 29 – Hangers and Supports for Electrical Systems
   4. Section 26 05 33 – Raceway and Boxes for Electrical Systems
   5. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.5 DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.

2. The terms “shall” is mandatory, “will” is informative, and “should” is advisory.
3. “Provide” – To supply, install, connect, and configure, for safe intended normal operation.
4. The terms “Indicated”, “shown”, or “noted” – As indicated on drawings or specifications.
5. The terms “Equivalent”, “similar”, or “equal” – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
6. The terms “Reviewed”, “satisfactory”, “accepted”, “approved”, “directed” – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner’s Representative.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
      a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
      b. International Building Code / BOCA National Building Code
      c. National Electrical Code (NEC)
      d. American Standards Association (ASA)
      e. Electronics Industries Association (EIA)
      f. Institute of Electrical and Electronic Engineers (IEEE)
      g. National Electrical Manufacturers Association (NEMA)
      h. Occupational Safety and Health Administration (OSHA)
   2. National Fire Protection Agency NFPA
      a. NFPA-70 National Electric Code
      b. NFPA-72 National Fire Alarm and Signaling Code
   3. ANSI / TIA / EIA:
      a. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
      b. TIA / EIA: 606a Telecommunications Infrastructure Standard
      c. TIA / EIA: 607 Grounding and Bonding Requirements
      d. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History

1.1 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide infrastructure and pathway that shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements as applicable.

B. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.

C. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner’s Representative.

1.2 SYSTEM DESCRIPTION AND REQUIREMENTS

A. The following is for a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and

the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.

B. Materials:
   1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
   2. The following list of main items of the installation shall not be considered to be all-inclusive:
      a. Wall boxes singe gang
      b. Wall boxes dual gang
      c. Conduits and connectors
      d. Conduit bushings
      e. Pull boxes
      f. Hangers and support for conduits and pull boxes.
      g. Cable trays
      h. Wiring troughs

1.3 RELATED WORK

A. Conduits:
   1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays as specified in part within this specification and associated drawing set.

1.4 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.

B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.5 PROJECT SCHEDULE

A. Project schedule shall follow the division 0, construction schedule

1.6 BID/TECHNICAL PROPOSALS

A. Bid proposal shall follow division 0, and the general contractor requirements for bidding.

1.7 PRE-BUILD AND FINAL SUBMITTALS

A. Submittals requirements shall follow division 0, and the general contractor requirements for submittals.

1.8 PROJECT CONDITIONS

A. Verify conditions on the jobsite applicable to this work. Notify General Contractor and or Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

1.9 QUALITY ASSURANCE

A. Quality Assurance requirements shall follow division 0, and the general contractor requirements for quality assurance.

1.10 PRE-INSTALLATION MEETING/SCHEDULE

A. If applicable Pre-installation meeting and schedule shall follow division 0, and the general contractor requirements for meeting attendance.

1.11 FINAL INSPECTION AND TESTING / COMMISSIONING

A. Inspection and testing requirements shall follow division 0, and the general contractor requirements for inspection.

1.12 WARRANTY

A. Warranty requirements shall follow division 0, and the general contractor requirements for warranties for materials and labor.

1.13 INSTRUCTION OF OWNER PERSONNEL

A. No instructions are required as part of this specification section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All material shall be new unless otherwise noted in this specification.

B. All materials must be UL listed or built to UL standards, where required.

2.2 GENERAL

A. Paint all wall and ceiling mounted infrastructure devices as directed by the Consultant/Architect.

B. The Contractor is responsible for providing a complete pathway infrastructure.

2.3 PRODUCTS

A. The quantities of boxes, conduits and accessories shall be determined and installed by the Contractor based on the requirement to provide a complete pathway solution

B. General: Raceways and boxes shall be constructed of the manufacturer's standard materials, as listed in published product information; types and sizes shall be as indicated or as required for the installation

C. Conduit and Outlet Box System:
   1. Empty conduit and outlet box system complying with sections 16050 and 16820.
   2. Not less than ¾" conduit size and larger conduit sizes as indicated.
   3. Outlet Boxes:
   4. 1 gang box – 2-1/8 inches deep by 2-1/8 inches high with 1 gang ring.
   5. 2 gang box – 2-1/8 inches deep by 4-11/16 inches square with 2 gang ring.
   6. 6" x 6" NEMA Type 1 enclosure
   7. 8" x 8" NEMA Type 1 enclosure
   8. 10" x 10" NEMA Type 1 enclosure
   9. 12" x 12" NEMA Type 1 enclosure
   10. Others as required or per manufacturer's recommendation

D. Cover Plates
   1. Comply with Section 26 05 00 and 27 51 16.

E. Provide blank plates for all outlet boxes that are not utilized for each phase.

F. Floor Boxes: Shall be as follows:

1. Type: Unless otherwise indicated, floor boxes shall be fully adjustable, UL listed, CUL listed, scrub water approved and not less than 480 in3 in volume. Adjustment leveling feet shall provide 1/8 inch (minimum) vertical or angular (tilting) adjustment.
2. Cover Plates: Unless otherwise indicated, cover plates for floor boxes shall be made of heavy steel not less than 11-gauge thick and each shall be provided with a 0.25 inch aluminum ring (SLP-type) or flange permanently attached to the adjusting ring.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install raceway and outlet box system continuous from outlet to junction box and to equipment location with no more than four (2) quarter bends (180 degrees total) without a pull box.

B. Install raceway from outlet boxes to cable tray in corridor as indicated. Bush and ream conduit ends and terminate with insulated bushings. Clamp conduit to structure as required for proper support.

C. Provide fittings as required and appropriate to the installation conditions.

D. Install raceway from outlet boxes to accessible ceiling spaces. Bush and ream conduit ends and terminate with insulated brushings.

E. Where cable tray/ladder is not utilized, make continuous runs from box to box with isolation from building systems as required.

F. Install boxes as indicated or as necessary, complying with the manufacturer's written instructions, applicable requirements of codes and standards, and according to recognized industry practices. Finished installation shall have a 4 hour minimum fire rating.

G. Knockouts: Open only knockouts which will be used for a conduit. Install tight fitting knockout closers in holes from which conduits have been removed.

H. Box Supports: Fasten raceways and boxes securely in place, using any approved spring clips and other fasteners, required in Section 26 05 29 - Supporting Devices.

I. No Extension Rings: Install boxes which provide the required volume without the use of extension rings.

J. Masonry Boxes: Install masonry boxes where boxes are recessed in wood, concrete block or brick or wood paneling. Saw-cut the opening for the boxes so that they will fit snugly in the opening. Install boxes with front edges flush with adjacent surfaces.

K. Cast Metal Boxes: Install cast metal boxes with weatherproof covers under any of the following conditions:
   1. Exterior locations
   2. Where exposed to moisture
   3. In exposed rigid steel conduit systems

L. Boxes for Receptacles: Shall be equipped with a grounding terminal screw.

M. Boxes for Electronic Security, Signal and Alarm use: do not require a grounding terminal screw.

N. Box Covers: Install blank box covers for all future infrastructure locations and pull boxes that are appropriate for the box, type of outlet and device, and with additional requirements as follows:
   1. For boxes recessed in gypsum wallboard, install raised device covers.
   2. For exposed, surface mounted boxes, install covers deep drawn 1/2 inch, with height and width dimensions identical to the associated box.
   3. For cast metal boxes, install gasketed, cast metal covers.

O. Care for Insulation: Replace any thermal insulation cut or damaged during installation of boxes.

P. Floor Box Adjustment: Adjust floor boxes and covers so that cover plates are flush with the finished floor around the entire circumference.

Q. Contractor shall provide seismic bracing for appropriate infrastructure where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 FIRESTOPPING

A. Comply with requirements in Section 078400, Penetration Fire-stopping.

3.3 GROUNDING

A. For low-voltage wiring and cabling, comply with requirements in Section 260526, Grounding and Bonding for Electrical Systems.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553, Identification for Electrical Systems.

3.5 LABELING

A. Conduit Labeling:
   1. Conduits shall be marked and or labeled as to indicate conduit usage and device type. Contractor shall develop a conduit labeling scheme for approval by owner's representative and or consultant prior to implementation.

3.6 CONTRACTOR TESTING AND COMMISSIONING

A. Perform tests and inspections.
   1. Tests and Inspections:
   2. Visually inspect conduit labeling, bend radius and connections. Verify pull strings have been provided, conduits are free of debris, are deburred, and boxes are free of dirt and debris.

B. Prepare test and inspection reports.

3.7 CONSULTANT ACCEPTANCE TESTS

A. Owner's Representative and or consultant shall approve conduit testing / inspection reports.

B. Owner's Representative and or consultant shall inspect conduits prior to concreate pours and or wall close in.

C. Final Owner's Representative and or consultant acceptance will performed along with the acceptance of completed systems as described in Section 28 13 00 - ALARM AND ACCESS CONTROL and or 28 23 00 - VIDEO SURVEILLANCE (VSS) & CLOSED CIRCUIT TELEVISION (CCTV)

END OF SECTION

SECTION 28 13 00 - ALARM AND ACCESS CONTROL

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide and install complete and operational Alarm (ALM) and Access Control System (ACS) as outlined in these specifications and related drawings and documentation requirements as set forth within this documentation.
   2. It is the responsibility of the Contractor to provide all wiring, plates, connections, and miscellaneous equipment for complete and operational system even if specified in this or other related documents or not.

B. Coordination, provision, installation, inspection, testing, instruction, and warranties of the ALM and or ACS systems.

C. All facilities, materials, equipment, transportation, and necessary labor for a complete and operational ALM and or ACS system.

D. Additional contractor requirements:
   1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
   2. Verification of dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturer's recommendations.
   4. Submittal information and provisions.
   5. Documented ALM and or ACS System testing procedures.
   6. Instruction of operating personnel.
   7. Manuals and provisions thereof.
   8. Maintenance and warranties.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including Divisions 0, 1, 15, 26, 28, and the general contract specifications.

B. Related specification sections:
   1. Section 28 23 00 - VIDEO SURVEILLANCE & CLOSED-CIRCUIT TELEVISION
   2. Section 28 05 28 - CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
   1. Section 07 84 00 - FIRESTOPPING
   2. Section 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
   3. Section 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
   4. Section 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
   5. Section 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

1.5 DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
   2. The terms "shall" is mandatory, "will" is informative, and "should" is advisory.
   3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
   4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
   5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
   6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
   7. The term "Professional grade" – Equipment that is intended for commercial use, use and is rated for continuous 24-7 use.
   8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
   9. The term "Labels" – refer to labels on audio-visual equipment as outlined in Section 3.4.
   10. The abbreviation "OFE" refers to items that are Owner Furnished Equipment
   11. The abbreviation "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment
   12. The abbreviation "VSS" refers to video surveillance system.
   13. The abbreviation "CCTV" refers to closed circuit television camera systems and components.
   14. The abbreviation "ALM" refers to an integrated alarm system and components.
   15. The abbreviation "ACS" refers to an integrated access control system and components.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:
   1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
      a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
      b. International Building Code / BOCA National Building Code
      c. National Electrical Code (NEC)
      d. American Standards Association (ASA)
      e. Electronics Industries Association (EIA)
      f. Institute of Electrical and Electronic Engineers (IEEE)
      g. National Electrical Manufacturers Association (NEMA)

h. Occupational Safety and Health Administration (OSHA)

2. National Fire Protection Agency NFPA
   a. NFPA-70 National Electric Code in particular the following sections:
      1) Sect 300: Wiring in ducts plenums, and other air handling spaces
      2) Sect 318: Cable trays
      3) Sect 645: Electronic Computer / data processing equipment.
      4) Sect 760: Fire protection signaling system
      5) Sect 770: Optical fiber cables
      6) Sect 780: Closed-Loop and programmed power distribution
   b. NFPA-71 Installation, Maintenance and use of Signaling Systems for Central Station Service.
   c. NFPA-72 National Fire Alarm and Signaling Code
   d. NFPA 72-D - Installations, Maintenance and Use of Proprietary Protective Signaling Systems
   e. NFPA 75 Protection of Electronic Computer Data Processing Equipment
   f. NFPA 262: Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
3. IEEE
   a. IEEE 802.3: STANDARD FOR LOCAL AREA NETWORKS
4. Underwriters Laboratories (UL)
   a. UL Listed- Underwriter's Laboratories Listed
   b. UL 83: Thermoplastic-Insulated Wires and Cables
   c. UL 294: Access Control System Units / ULC Standard for Access Control Systems
   d. UL 611: Central Station Burglar Alarm Units and Systems
   e. UL 634: Standard for Connectors and Switches
   f. UL 639: Standard for Intrusion Detection Units
   g. UL 1076: Proprietary Burglar-Alarm Units and Systems
   h. UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
   i. UL 1635: Standard for Digital Alarm Communications System Units.
   j. UL 1655: Standard for Community-Antenna Television Cables
   k. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
   l. UL 1950 Information Technology Equipment, including Electrical Business Equipment
5. ANSI / TIA / EIA:
   a. ANSI C2: NATIONAL ELECTRIC SAFETY CODE
   b. ANSI X3T9.5 STANDARD FOR FIBER DISTRIBUTED DATA INTERFACE (FDDI)
   c. TSB-67: TRANSMISSION PERFORMANCE FOR FIELD TESTING OF UTP CABLING SYSTEM
   d. TIA-222 STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS
   e. EIA 232-D Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Serial Binary Data
   f. EIA RS-310-C Racks, Panel, and Associated Equipment
   g. TIA-455-78 Revision B, FOTP-78 IEC 60793-1-40 Optical Fibers - Part 1-40: Measurement Methods and Test Procedures – Attenuation
   h. TIA 568-B.1-2000 Telecommunications Standard

i. TIA-568-C.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS
j. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
k. TIA / EIA: 606a Telecommunications Infrastructure Standard
l. TIA / EIA: 607 Grounding and Bonding Requirements
m. EIA/CEA: 861 A DTV Profile for Uncompressed High Speed Digital Interfaces.
n. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History

6. Video Coding Experts Group VCEG
   a. H.262[1] or MPEG-2 Part 2
   b. H.263
   c. H.264/MPEG-4 AVC
   d. H.264 or MPEG-4 Part 10
   e. H.265 or High Efficiency Video Coding (HEVC),
7. References to codes and standards called for in the Specifications refer to the latest edition, amendments, and revisions to the codes and standards in effect on the date of these Specifications.

1.7 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide an ALM and or ACS System compatible with the Owner's existing systems and operations as applicable.

B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.

C. The Contractor shall provide a complete and operational system configured and installed for user-friendly operation and low maintenance.
   1. Provide one adjustment and calibration of the ALM and or ACS systems, as directed by the Owner's Representative, before Final Acceptance.
   2. Provide one adjustment and calibration of the ALM and or ACS systems, as directed by the Owner's Representative, after Final Acceptance.

D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.

E. The contractor shall restore finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.

F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.

G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.

H. All finalized software affiliated with the equipment, including but not limited to, the DSP, Control System, etc. is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.

I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all

passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM DESCRIPTION AND REQUIREMENTS

A. The following is for a basic system description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.

B. The ALM and or ACS Security System for the Location makes up the security hardware/software portion of the clients programmatic use requirements. The Security System will be a state-of-the-art system designed to comply with the requirements for an access control and proprietary alarm monitoring system.

C. Materials:
   1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
   2. The following list of main items of the installation shall not be considered to be all-inclusive:
      a. Devices:
         1) Access control panel (ACP)
         2) Card Reader (CR)
         3) Door Position Sensor / Switch (DPS)
         4) Door locks/lock with power supplies.
            a) Electric Strike (ES)
            b) Electric Lockset (ELS)
         5) Proximity Exit Sensor (PIR)
         6) Central Processing Unit (CPU)
      b. Modems and all related communication equipment.
      c. Printers
      d. All power supplies and transformers.
      e. Master Deck, or work station.
      f. Computer(s)
      g. Wire for readers and or panel communications connections.

D. Provide and install all equipment, components, wire, cable, antennae, and associated mounting hardware as required to meet manufacture's specifications and documented installation procedures.

E. All material and equipment shall be standard, regularly manufactured equipment. All systems and components shall be thoroughly tested and proven in actual field use. Where possible, all system components shall be from one manufacture. Whenever components are included from sources other than the manufacture of the system, the Contractor shall demonstrate and verify that the components are compatible, prior to the system acceptance, and shall provide to the Owner that use of such components will not void or impair the system warranty.

F. The Security System will provide continuous year-round, 24 hours-per-day, 7 days-per-week operation. The major function of the Security System will be to provide controlled access, intrusion detection, surveillance and assessment and communications as required.

G. The Security System will incorporate the necessary components to collect, transmit and process alarm, tamper and trouble conditions, advisories and access requests in accordance with security procedures. The Security System will support the normal flow of authorized personnel and vehicles through controlled-access points to maintain facility operating efficiency.

H. The Door Access System shall be a modular, networked access control system capable of handling large proprietary corporations with multiple sites, alarm monitoring. The system shall also allow for easy expansion or modification of inputs, outputs, and remote-control stations.

I. The Door Access system shall be TBD and interface with their existing systems.

J. The system shall monitor, control, secure, track, and record any activity at any of the given door locations that are associated with the Door Access System. The System shall control the doors via the control center, and can independently operate if the main CPU fails to operate. The doors shall be secured by electronic strikes, and will either be controlled by card reader access, manual operation, software control, or by egress.

K. The Contractor shall comply with all codes, licenses, and regulations for state, county, and/or local governing body. This includes but not limited to: fail safe operating, power failure, and interfacing with fire control system.

L. The cards readers shall be placed and programmed so that the operator can easily operate the reader and enter the building. The motion egress and push button egress units shall be located and programmed so that it will allow for a user to exit the door, but will re-lock at a set time, and will not trigger for background motion.

M. The main control computer shall be programmed to monitor all alarm input and output points. The CPU operator shall also be able to lock or unlock at door at any given time. The main CPU shall be where all programming shall be done to the system, and then downloaded to all associated panels.

N. The system shall provide both supervised and non-supervised alarm point monitoring. Upon recognition of an alarm. The system shall be capable of alarming or disarming alarm points both manually and automatically, by the time of day, and by the day of the week.

O. Access control functions shall include validation based on time of day, day of week, holiday scheduling, site code and card number verification, automatic or manual retrieval of cardholders' photographs, and access validation on positive verification of card or card and PIN.

P. Alarm events with defined priorities shall be able to pop-up automatically in an Alarm event window for operator attention. The pop-up shall display the name of the event (reader, alarm point, card holder, or the system alarm), time, date, if a card event; the card number, type of event and cardholders name. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgment or Clearing the event. Event instructions shall be made available by double clicking on the event.

Q. The alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not limited to: acknowledge, clear, open a preprogrammed floor plan, energize, de-energize, pulse, time pulse, add comment, shunt or un-shunt.

R. The system programming shall be user friendly, and capable of being accomplished by personnel with no prior computer experience.

S. After installation, the Owner shall be able to perform hardware configuration changes. These hardware configuration changes shall include, but not limited to, door open time, door contact shunt time, point and reader names, when and where a cardholder is valid, and the ability to add or modify card databases as desired without the services of the Contractor or Manufacturer.

T. System Monitoring and Control
   1. The Security Desk, located WHERE, will be the focal point for monitoring and controlling Security System equipment. Since the Security Desk may not be manned continuously, it will be able to operate unattended. When the Security Desk is not manned, security-related

functions will be performed at the WHERE. At a minimum, the Security Desk will contain an operator workstation with dual LCD monitors, a keyboard and mouse, a Closed-Circuit Television (CCTV) keyboard and a master intercom station. The WHERE will be equipped with an operator workstation with an LCD monitor, a keyboard and mouse and a master intercom station. To preclude unauthorized use, the operator workstations will be protected by a multi-level password scheme. All operator log-on and log-off transactions will be automatically stored in a historical file for future recall.

U. Data Processing and Storage

V. The processing and storage of system status and database information will be performed by the Access Control System (ACS) server to support the real-time operation of the Security System and for the initiation of system data and control signals in response to operator requests and software application programs. The ACS server will be rack-mounted in the MDF Room. The ACS server will communicate with the operator workstations over the facility Local Area Network (LAN) via CAT6 cable.
   1. To assure adequate expansion capability, ACS server working memory and archival storage will be provided with a spare capacity of at least 50 percent of initial requirements with provisions for a minimum growth capability of 100 percent of initial capacity.
   2. To prevent unauthorized access and manipulation, the ACS server programs and databases will be protected by a multi-level password scheme.

W. Signal Transmission
   1. The Security System will support a distributed data collection and processing scheme. The ACS server will interface with ACS field equipment via Intelligent Field Panels (IFPs). The IFPs will be hardwired to all monitored and controlled-access point devices to collect and transmit status information to the ACS server for processing and/or storage. IFPs will be located in the MDF Room, in the Electrical Rooms on floors one through four, in the IDF Rooms on floors two through four and at vehicle gates VG 1, VG 2 and VG 3.
   2. An independent IFP will be provided for the SCIF Room on the 3rd floor. This IFP will be hardwired to a dedicated operator workstation in the room. The IFP will provide common contact outputs for alarm, tamper and door held open for monitoring by the AC server via an IFP outside the room
   3. Interior IFPs and exterior IFPs within 290 feet of a LAN drop will communicate with the ACS server over the facility LAN via CAT6 cable. Exterior IFPs more than 290 feet from a LAN drop will communicate with the ACS server via fiber optic cable. If communications with the ACS server is disrupted, each IFP will have provisions to store a minimum of 5,000 authorized access transactions, off-normal events and monitored point resets locally. Upon restoration of communications, the IFPs will upload the stored data. Data uploading will not interfere with the real-time reporting of subsequent off-normal events and resets.
   4. Video signals from interior CCTV cameras and exterior CCTV cameras mounted on the side of the building will be transmitted to the nearest dedicated Surveillance and Assessment System (SAS) network switch via CAT6 cable. A SAS Layer 3 network switch will be provided in the MDF Room. A SAS Layer 2 network switch will be provided in the third floor Electrical Room. Video signals from CCTV cameras on the roof and near vehicle gate VG 2 will be transmitted to the SAS network switch in the MDF via fiber optic cable.
   5. The design of the Security System will incorporate line supervision features to detect any attempt to compromise the signal lines between system components. The level of line security provided will meet or exceed the requirements for Grade AA service as defined in UL 1076.

6. IP master and remote intercoms within 290 feet of a LAN drop will communicate over the facility LAN via CAT6 cable. Exterior remote intercoms more than 290 feet from a LAN drop will communicate via fiber optic cable.

X. Controlled Access
1. The Security System will monitor and control personnel and vehicle access to WHERE and the associated employee and secured parking lots and at selected doors within the facility based on the presentation of a valid cardkey at a card reader. Unauthorized access requests will be denied, and an advisory will be annunciated at the operator workstation(s). Card readers will utilize proximity technology. Each card reader will be provided with separate visual indications that access has been granted or denied. Access will be controlled by assigning any combination of controlled-access points to each individual for authorized access. Access may be further controlled by assigning a time zone for access at each controlled-access point. All access transactions will be archived.
2. Normally, access authorization decisions will be made locally at the associated IFP. Sufficient local memory will be provided to store all access authorization data for up to 500 individuals. Access authorization data will be automatically downloaded from the ACS server to each IFP, as appropriate. If authorization data for an individual requesting access is not found at the associated IFP, the ACS server will be queried for a decision.
3. If an access request is authorized at a controlled-access door/pedestrian gate, the IFP will generate signals to unlock the associated electrical lock and shunt the associated door/gate position switch to permit unalarmed entry. The door/gate will relock and the door/gate position switch will be un-shunted as soon as the door/gate closes after entry. In the event the door/gate is not closed within a predetermined time period (programmable) a held open advisory will be annunciated at an operator workstation(s). Each controlled-access door/gate will be equipped with a request-to-exit sensor or exit pushbutton to shut the door/gate position switch for unalarmed exit.
4. If an access request is authorized at a controlled-access gate, the IFP will generate signals to open the associated gate and shunt the associated gate position switch (if so equipped) to permit unalarmed entry. A vehicle loop detector inside the gate will close the gate and un-shunt the gate position switch after the vehicle enters. Upon exit, a vehicle loop detector inside the gate will open the gate and shunt the associated gate position switch (if so equipped). A vehicle loop detector outside the gate will close the gate and un-shunt the gate position switch after the vehicle exits.

Y. Intrusion Detection
1. Controlled-access doors, gates and monitored doors/gates will be equipped with door/gate position switches to detect authorized and unauthorized opening. The door to the SCIF will be equipped with a balanced magnetic switch.
2. A dual technology motion sensor will be provided inside the SCIF to detect unauthorized movement within the area.
3. Tamper switches will be provided within all accessible Security System enclosures, cabinets and door junction boxes (except boxes associated with the SAS) to detect unauthorized opening or tampering.

Z. system programming
1. Database: The Contractor shall assist the Owner in setting up the system database requirements and formats. Forms to be utilized in collecting and entering all data shall be provided to the Owner by the Contractor. Written instructions on the use of all forms shall be included. Examples of the sequence of completion for all related forms shall be provided. The Owner shall be responsible for the actual data collection and entry to ensure a complete understanding of the system and its contents.

2. Programming: The Contractor shall initially configure the system in accordance with the design shown in the drawings. All access control requirements, alarm point definitions, camera/monitor, alarm point call up and in/out relationships, individual component descriptions, and any other programmable parameters required shall be as shown in the appropriate drawings and schedules. The Owner shall perform any additional programming with the assistance of the Contractor. All programming must be approved by Owner for approval before installation is started.

1.9 RELATED WORK

A. Conduits:
1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.

B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.11 SCHEDULING

A. The Contractor shall submit a schedule to the Owner for approval. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off of project. This schedule shall be submitted on Microsoft Project, both paper and electronic format, with submittals.

B. It shall be the responsibility of the Contractor to coordinate the installation of the system to be compatible with the work of the other trades. The Contractor shall attend weekly progress meetings and provide continuous on-site project management.

C. It shall be the responsibility of the Contractor to arrange with the Owner a mutually acceptable time for Acceptance Testing, based upon the dates provided in the Solicitation.

1.12 PROJECT SCHEDULE

A. Schedule shall be based on project schedule issued by the owner and/or General Contractor

1.13 BID/TECHNICAL PROPOSALS

A. The ALM and or ACS System Installer shall be experienced in the provision of systems similar in complexity to those required for this [project and shall at least meet the following criteria:
1. The primary business of the Contractor/Installer shall be the installation of ALM and or ACS systems.
2. At least five (5) years' experience with the specified equipment and systems.
3. Experience with at least one project of similar size and complexity as outline in these specifications.

4. Be an authorized dealer and service facility for the products specified and furnished.
5. The Contractor shall provide personnel with extensive training for each system type and configuration.
6. The Contractor shall maintain a fully staffed installation crew and service crew for maintenance and installation of the specified systems.
7. Lead Installer shall have factory training in support of installed systems and equipment.
8. Contractor shall demonstrate that the installation staff consists of certified security professionals.
9. Final ALM and or ACS System configurations shall be approved by the Owner's Representative, Architect and Consultant.
10. At the request of the Owner, Contractor shall demonstrate that he has:
    a. Sufficient facilities and equipment for this work.
    b. Sufficient staff with the appropriate technical expertise and experience for this project.
11. All Bid proposals shall be valid for ninety (90) days from date received.
12. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment

B. Provide a list of five (5) references with locations, names of contacts, and contact phone information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old.

C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents and drawings, manufacturer requirements, and RFI responses as applicable.

1.14 PRE-BUILD AND FINAL SUBMITTALS

A. Provide the following for approval sixty days after Notice to Proceed and prior to commencement of work:
1. A complete list of all products to be incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
3. Provide shop drawings as defined in the section below.

B. Shop Drawings:
1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of systems.
2. All drawings shall be scaled appropriately but not less than 1/8" =1'.
3. Schematic detailed wiring diagrams showing interconnection of Contractor provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
4. Show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling within housing.
5. Show all A.C. power outlet locations and terminal strip locations within each equipment rack.

6. Plans and sections of the building and adjacent grounds showing the location of all installed equipment such as loudspeakers, racks, consoles, plates/panels, antennas, (etc.).
7. Patch panel layouts and labeling strips, including color schemes as necessary.
8. Full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
9. Provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate.
10. Complete labeling schemes for all cabling and equipment components for the project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
11. A complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout with a t least a 20% oversize for project utilization for future system growth.
12. Provide a complete conduit riser and associated conduit plans for a complete conduit system. Include a Junction Box schedule showing type, size, mounting style, and location of each box.

C. Submittal Format: (PDF version)
1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
2. Separate major groupings Use multiple volumes / list of content
3. Index product data sheets by manufacturer and model or part number.
4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
5. Reference addendum or change order numbers as applicable.
6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
7. Provide via pdf, posted to FTP, thumb drive and or CD / DVD ROM.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

D. Submittal Format: (Printed Option if specifically Required)
1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
6. Reference addendum or change order numbers as applicable.
7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

1.15 PROJECT CONDITIONS

A. Verify conditions on the jobsite applicable to this work. Notify Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.16 QUALITY ASSURANCE

A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.

B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating Integrated Security Management Systems which include access control and alarm monitoring. Manufacture shall be able to similar installations rendering satisfactory service.

C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.

1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.
2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.17 PRE-INSTALLATION MEETING/SCHEDULE

A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.

B. A Conduit/Wiring Analysis shall be conducted at the Pre-Installation Meeting. The Contractor shall submit "as-built" drawings locating all existing conduit runs, junction boxes, and electrical outlets. Show location and type of all special receptacle boxes and plates to be supplied and/or modified by the Contractor. Verify and inspect all necessary conduits and outlets. Provide with the submittals, a list of all conduits, boxes, and power changes necessary for installation of systems in each location.

1.18 FINAL INSPECTION AND TESTING / COMMISSIONING

A. Upon completion of installation and Contractor testing and commissioning (as outlined in sections 3.6), the Consultant shall perform system(s) inspection and testing (as outlined in section 3.7).

B. To assist the Consultant by providing a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the system(s).

C. Process of testing the system(s) may necessitate moving and adjusting certain components such as PIR sensor and or glass break location adjustments.

D. Testing will include operation of each camera and sub system and any components deemed necessary. Provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.

E. In the event that further adjustments or work is required during testing, the Contractor shall continue his work until the system(s) is acceptable at no addition to the contract price. If approval is delayed due the defective equipment, and/or failure of equipment or installation to meet the requirements of this specification, the Contractor shall pay for additional time and expenses of the Owner at the rate specified by the Owner.

1.19 WARRANTY

A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial one-year service contract.

B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.

C. The Contractor shall respond with remedy to a trouble call within twenty-four (24) hours after receipt of such a call, and shall provide a 24-hour service phone number. Uptime for system(s) shall be no longer than 24-hour period. All replacement parts/components shall be of equal or higher level for service.

D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

E. At least two routine inspection and adjustment visits will be scheduled for the first year. Submit reports to Owner.

F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.

1.20 INSTRUCTION OF OWNER PERSONNEL

A. After final inspection and completion, provide instruction to Owner designated personnel on the operation and maintenance of the system(s).

B. Develop an instructional course based on the use of the system(s) and manufacturer's recommendations. Provide a minimum of five (5) hours of instruction. Arrange course so that operational and maintenance classes are separate.

C. The training plan or class shall include detailed sections outlines and related reference materials. The Owner personnel shall be able to utilize these materials in the subsequent training of their co-workers.

D. Submit an outline of the course with sample instructional aids for approval thirty (30) days prior to scheduled instruction sessions.

E. The training time shall not be less than a total of 32 hours, and shall consist of:
   1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
   2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
   3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's telecommunications personnel.

F. The specified training schedule shall be coordinated with the Owner and will follow the training outline submitted by the Contractor as part of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electronic component models shall be commercially available for a least one (1) year prior to bid, or be approved by the Consultant and or Owner's Representative.

B. All equipment and material shall be new.

C. All equipment must be UL listed or built to UL standards, where required.

2.2 GENERAL

A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied, unless a variance (separate document) is submitted and approved by the Owner's representative and or Consultant.

B. System shall be installed and configured for simplicity of operation, with user-friendly controls.

C. Provide product quantity as required for a complete and operable system. If any quantities are given, the Contractor shall provide at least the given amount. Some of the product listed under this section may not be required to fulfill the work as outlined.

D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.

E. Remove all manufacturer's nameplates or logos from product, as required, within the public site lines or spaces.

F. Paint all wall and ceiling mounted devices as directed by the Consultant/Architect.

G. The Contractor is responsible for providing a fully operational, turnkey ALM and ACS systems.

2.3 PRODUCTS

A. The quantities of components shall be determined and installed by the Contractor based on the requirement to provide a fully operational Integrated Security Management System, as per the intent of the specification, and as shown on the drawings and recommended by the Manufacturer.

2.4 FRONT END SYSTEM

A. For performance PC system configurations that require high availability, the manufacturer shall be consulted for appropriate custom PC system configuration.
   1. Computer Specifications:

2. Standard PC Specification:
3. CPU shall be a Pentium 4 2.4 GHz
4. RAM shall be 521 MB DDR SDRAM 333Mhz
5. Hard disk shall be a 9GB SCSI or larger (Increased drive capacity shall be required in badging applications depending on image compression.)
6. 3.5" floppy disk and CD drive
7. Monitor shall be 17" 1024 x 768 true color or larger
8. 2 button mouse (PS2 mouse preferred)
9. Standard 101-keyboard layout and IBM-compatible keyboard
10. 20 G, IDE Tape BU
11. 2 serial communication ports
12. 1 parallel port (2 parallel ports for badging
13. Microsoft Windows XP Professional, Windows 2000 Professional Service Pack or Windows NY 4.0 with Service Pack 6a
14. Video Card
15. CD Drive: 48x
16. Acceptable product:
    a. TBD

2.5 FRONT END SOFTWARE REQUIREMENTS

A. Specifications for software:

1. The System shall interface with the existing control access software.
2. Monitor Display: The software shall display all system activity on a color monitor in real time, except for remote locations configured as dial-up. The software shall allow a WAV file to be played upon all alarm conditions. The software shall provide an acknowledge function for all incoming alarm messages that are defined for alarm acknowledgment.
3. Disk Storage: The software shall store user-selected activity on the hard disk. Report options shall recall selected history information from the hard disk. The user may request report information based on selected cardholders, specific areas and/or specific times. The software shall allow archiving by defined dates.
4. English Descriptions: The software shall support descriptive names for all database entries. The card database shall include name, number, PIN, access level, status, activation, and expiration date or limited usage and 40 user-defined fields.
5. Password Protection: The software shall provide multi-level password protection, with user-defined operator name/password combinations. Name/password log-on shall restrict operators to selected areas of the program. The software shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change or delete.
6. Action Messages: The software shall allow recall of user created text messages upon any condition.
7. Graphics: The software shall allow recall of user created screen graphics, upon alarm/trouble/normal conditions. These graphics shall allow the user to go from a general area to a specific area in various layers or stages and shall allow the user to monitor and control system devices from floor plans.
8. Manual Panel Control: The software shall allow manual control of selected inputs, outputs and groups of outputs. Manual panel control shall include pulse, timed pulse, and energize/de-energize or return to time zone options for output points and shunt/unshunt or return to time zone options for input points. For entrances and readers manual control shall include but be limited to Lock, Un-Lock, Shunt, Un-Shunt, Pulse and Timed Pulse.
9. Acceptable product:
    a. TBD

2.6 CONTROL PANEL

A. Power Distribution Panel

1. 12VDC/6A power for controllers
2. Battery backup for controllers
3. Lock power 12VDC-8A/24VDC-4A-8A
4. UL 294/UL 1076
5. AC loss/low battery supervisory outputs
6. Fire override input and output
7. Acceptable product:
    a. TBD

B. Intelligent Control Panel
1. Scalable architecture 2-8 doors
2. TCP/IP communications
3. Individual intelligence
4. 512K RAM/512K flash ROM
5. UL 294/UL 1076
6. 240+ card and keypad formats
7. FIPS/TWIC card compatibility
8. Real time processing and communications
9. Integrated power supply and distribution
10. 16 inputs for standard point monitoring
11. 16 inputs for door position and exit request
12. All inputs support two, three, and four state monitoring
13. Form C relays 8
14. UL294 listing/CE certification
15. Relay output ratings 5 amp-30VDC
16. Access controlled entry points card reader or keypad-8
17. Nema type 1 equivalent enclosure with lift off hinged door, lock/key and tamper switch.
18. Time codes: 63 per controller
19. Elevator support: 32 groups
20. Communication support: RS-485; 20mA
21. Acceptable product:
    a. TBD

C. Intelligent Control Panel
1. 32 programmable inputs
2. 2, 3, 4 state monitoring
3. 4 digital outputs
4. UL 294/UL 1076
5. LED status for each input
6. Flexible I/O linking
7. Non-volatile memory available
8. 512K RAM/ 512K flash ROM
9. Scalable architecture
10. 16 inputs for door position and exit request
11. Acceptable product:
    a. TBD

D. Quadraplexor
1. RS-232/RS-485 inputs
2. Master to Slave star wiring
3. 4 RS-485/4 wire outputs
4. 1 rs-232/3 wire output
5. RS-232 diagnostic output
6. Protocol independent
7. TCP/IP communications

8. Powered by integral power supply or controller
9. Relays are time programmable for automatic control
10. Acceptable product:
    a. TBD

E. Master Comm Interface
1. RS-232 to RS-485 converter
2. RS-232 input via terminal block or DB25 female
3. RS-485 output via terminal block
4. 12VDC power by controller
5. Over voltage protection
6. UL 294/ UL 1076
7. Status LEDs
8. Protocol independent
9. Acceptable product:
    a. TBD

F. LAN Comm Interface
1. DSX/PC master/L85 software
2. Auto-sensing 10/100/auto duplexing
3. RS-232/RS485 controller communication
4. UL 294/ UL 1076
5. Dial up modem backup-optional
6. Static of dynamic IP communications
7. Acceptable product:
    a. TBD

G. Proximity Readers:
1. Mullion sizes and switch plate size
2. ADA compliant built-in audible buzzer
3. Tamper detect output (can erase security keys)
4. Maximum read range: 2.5-3.75 inches (6.4-9.5 cm)
5. Frequency: 13.56 MHz
6. ISO Standard Support: 14443A, 14443B, and 15693
7. Power Supply Type: Linear or Switching(Ripple,30 MHz, max 50mVss)
8. Operating Voltage Range: 5 – 16 VDC (works down to 4.25 VDC
9. Acceptable product:
    a. TBD

H. Ceiling Exit Button:
1. Door monitor with sounder alert
2. Sequential logic inputs
3. Internal vertical pointability
4. Wrap around coverage pattern with precise pattern control
5. Up to 64 seconds adjustable latch time
6. Selectable relay trigger mode
7. Selectable fail safe or fail secure modes
8. Acceptable product:
    a. TBD

I. Magnetic Door Contacts:
1. Designed specifically for use in steel doors

2. Special ribbed sides allow for easy installation
3. Rugged unibody construction for maximum durability and reliability
4. Regular, wide gap, SPDT, DPDT, and high security models available
5. Rare earth magnet designed for steel door with top channel
6. Acceptable product:
   a. TBD

J. Surface Mount Magnetic Door Contacts:
1. Wide gap for decreased installation time
2. Fewer false alarms
3. SPDT. DPDT, and high security
4. Acceptable product:
   a. TBD

K. Surface Mount Magnetic Door Contacts with Armored Cable:
1. Miniature low-profile design
2. Stainless steel armored cable for added security
3. Wide working gap for overhead doors
4. Aluminum bar stock resists corrosion in harsh environments
5. Acceptable product:
   a. TBD

L. Power Supply
1. Meets IEC61000-4
2. Power factor corrected
3. Level B EMI
4. Universal input
5. Acceptable product:
   a. TBD

2.7 PLATES AND PANELS

A. Provide plates and panels as described in the drawings and as required for a fully operable system.

B. Custom plated shall be 1/8" thick aluminum, standard EIA sizes, brushed black anodized finished unless otherwise noted.

C. Plastic plates are not allowed.

D. Lettering shall be in all caps and numbers engraved with a color contrasting to the base material with a minimum size of 0.25".
1. Font Size shall be 1/8"
   a. Font Style shall be Helvetica

E. Acceptable manufacturers of custom plates and panels:
1. RCI Custom
2. Panel Authority
3. Whirlwind

2.8 PROPOSED SUBSTITUTIONS

A. Where specific equipment is described, it is not the intention to discriminate against the products of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.

B. The Owner's Representative and or Consultant requires manufacturer's original specification tests. The Owner's Representative and or Consultant will evaluate and approve/disapprove all substitutions.

C. Items designated "no substitutions" shall be that specified item only. Submission of items other than specified shall not be considered and may disqualify RFP submission.

2.9 CABLES AND WIRING

A. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

B. Plenum Rated / Non-Plenum Ratings: Cable routed in conduits and or equipment racks can have non-plenum rated (PVC) jacket. All other cables shall have a plenum or riser rated jacket compliant to the cable run and purpose. Cable runs shall be continuous without splices.

C. Cable Selection: Based on signal type as indicated on single line diagram, noted at equipment input, or output connection type. Wire manufacturer and part numbers are provided as a basis of cable quality and signal characteristics. Alternate cable manufacturers to be requested for approval during pre-build submittal.

D. Provide cabling compliant with Section 28 05 13 - CONDUTORS AND CABLES FOR ELECTRONIC SAFETY

E. Provide the following cabling types as required for a fully operable system:
1. Communication outlet cables: 18 AWG 2 conductor shielded – West Penn 293
2. Control cables: 18 AWG 2 conductor shielded – West Penn 293
3. Antenna / CATV cable: RG-6 Quad Shield minimum refer to FCC / Cable provider recommendations as required.
4. Precision video cable: Belden 8281 as required.
5. Trunk video cable (RG6): West Penn Wire 841 (S).
6. Trunk video cable (RG11): West Penn Wire 821.
7. Video drop cable (RG6 Plenum): West Penn Wire 25841.
8. Trunk video cable (RG11 Plenum): West Penn Wire 25821.
9. 9-conductor 22AWG. communications cable: Belden 9945.
10. 9-conductor 18AWG. communications cable: Belden 83659.
11. Unshielded Twisted pair Category 5e Cabling West Penn Wire 254245
12. F/UTP Category 6 Cabling West Penn Wire 254246AF
13. Shielded Twisted pair HDBaseT Cabling Extron XTP DTP 24

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing.

B. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.

C. Units shall be installed parallel and square to building lines. All wires shall be gathered and fastened to create an orderly installation.

D. Electronic equipment shall be permanently mounted in equipment racks or as applicable to the equipment and application.

E. Contractor shall mount all equipment, mounting brackets, plates and panels, plumb and level.

F. Contractor shall follow all applicable standards including ASIS Commission on Standards and Guidelines documentation as a basis of design, fabrication, construction, and Performance Verification.

G. Contractor shall provide shaft locks or security covers on non-user operated equipment having front panel access.

H. Contractor shall permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.

I. Contractor shall validate bracing or blocking for proper mounting and safety.

J. Contractor shall provide seismic bracing for appropriate equipment where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 EQUIPMENT HOUSING

A. Equipment Enclosures / Racks:

1. Install all applicable equipment in racks and or wall mounts according to manufacturer's recommendations and product application.
2. Provide adequate ventilation, thermal management and temperature-controlled fans to maintain a rack temperature of less than 85 degrees Fahrenheit.
3. Provide rear support and rear rack rails for housing mounted equipment greater than 15" deep.
4. Allow a minimum of 20% open rack space to support future expansion.
5. Fill all empty spaces with blank panels, sizing as required; painted and or anodized to match housing.
6. Locate operator useable equipment and patch panels at an appropriate operating height.
7. Key all door locks for each housing type (front, rear) alike.
8. Looking at the equipment racks from the rear of the racks, install all AC power and ground cabling on the left and audio and video cabling on the right.
9. Provide LED lights mounted in the top of every two racks to illuminate the interior for service or maintenance. LED lights shall be individually switch-able and placed so as to provide maximum illumination throughout the rack.
10. Dress all loose cabling for a clean and orderly rack. The use of electrical tape for any cable management is prohibited.
11. The use of tie wraps for network and optical fiber cabling is prohibited
12. Provide nylon braded sleeving for wiring harnesses for a clean installation of cabling that is visible to user areas. Sleeving color shall be coordinated with location and device color.

3.3 PATCH PANELS

A. Video Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tie lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.

6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any console connections and interconnection of rooms and equipment.

B. Unshielded Twisted Pair UTP / STP RJ-45 Patch Panel Configuration:
1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Configure and terminate patch bay per TIA / EIA standards.

3.4 LABELING

A. Device Labeling:
1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

B. Rack Labeling:
1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
2. All rack panel labeling shall be engraved and filled.

C. Wire and terminal strip labeling:
1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
4. Wiring designator shall be alphanumeric code, unique for each cable.
5. Each cable type shall be labeled starting with different destinations (i.e. mic series "Mxxx", speaker series "Sxxx", etc.).
6. On projects that have multi room connectivity the source and destination room numbers should be the prefix for the cable number indicting a cable that traverses between two rooms.
7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.5 PERFORMANCE STANDARDS

A. All provided devices / equipment shall meet and or exceed published manufacturer's specifications and be compliant with the outlined salient capabilities as described in section 2 and be compatible with all applicable standards and configurations.

3.6 CONTRACTOR TESTING AND OR COMISSIONING

A. Prior to energizing or testing the system, ensure the following:
1. Execution: Activate all alarm or other output devices that are in the system for proper operation, including supervisory and trouble circuit tests.

2. Report: A checkout report for each piece of equipment shall be prepared by the Contractor and submitted to the Owner, one copy of which shall be registered with the equipment manufacturers. This report shall include a complete listing of every device, the date it was tested and by whom, and the results and date tested (if failure occurred during any previous tests). The final test reports shall indicate that every device tested successfully. Submit two typed copies of the test reports on 8 ½" x 11" papers, in a neatly bound folder to the Owner for approval. Failure to comply with this will result in a delay of final testing and acceptance.
3. All products are installed in a proper and safe manner per the manufacturer's instructions.
4. Insulation and shrink tubing are present where required.
5. Dust, debris, solder, splatter, etc. is removed.
6. Cable is dressed, routed, and labels and all connections are consistent with regard to polarity.
7. All labeling has been provided and installed.
8. All products are neat, clean, unmarred and securely fastened.
9. All debris has been cleaned and removed from the site.
10. All electronic devices are properly grounded.

B. Perform the following test. Record all results in the final project manual.
1. Test each AC power outlet for proper connections for hot, neutral and ground.
2. Measure and record the DC resistance for the technical ground in the equipment racks and console. Resistance should be 0.15 ohms or less.
3. After the testing report and as-built drawings have been approved by the Owner's representative, the completed system shall be tested in the presence of the Owner's representative.
4. Acceptance of the system shall require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day period with a 99% system on-line reliability. Should major equipment failure occur, the Contractor shall replace component(s) and begin another ninety (90) day test period. This test shall not start until the Owner has obtained beneficial use of the system. If the requirements provided in the paragraph above are not completed within six (6) months after beginning the tests described therein, the Contractor shall replace the System with another one from approved Manufacturer, and the process shall be repeated until final acceptance of the System and its equipment by the Owner.
5. Once the final test is complete, each purchased spare component must be inserted into the System and the System tested in potentially affected areas again to insure complete functionality. The original removed parts will become the System spares.

C. Input Verification Test: (Composite video)
1. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
2. Perform complete system operation to verify proper system operation.
3. In a similar manner, check any other inputs or tie-lines as appropriate.

D. Input Verification Test: (IP Cameras)
1. Verify video stream presence on network and verify resolution and color depth settings.
2. Configure IP address for each stream to muti-image processor and to recorder as specified.
3. Perform complete system operation to verify proper system operation.
4. In a similar manner, check any other cameras or streaming devices as appropriate.

E. Notification:

1. Once all of the above is complete, the system is ready for inspection. Formally notify the Owner's representative and or consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and configurations will be conducted at the time of inspection.

3.7 CONSULTANT ACCEPTANCE TESTS

A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined within section 3.6 has been completed and the test results have been received and reviewed by the consultant and or owner's representative.

B. Consultant acceptance testing will be conducted based on applicable sections of the ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard.

C. Checklist items within this list will be verified by visual and or audible methods as part of normal use case operational scenarios, with the assumption that the contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per section 3.6 above.

D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
   1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
   2. The operation of all system equipment shall be demonstrated by the contractor.
   3. Contractor shall provide a laptop to support testing activities that is configured and connected to any and all control processors for any evaluation and adjustments (tuning) activities by the consultant.
   4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection / configuration.
   5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
   6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
   7. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the consultant.

E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION

SECTION 28 23 00 - VIDEO SURVEILLANCE (VSS) & CLOSED-CIRCUIT TELEVISION (CCTV)

PART 1 - GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
   1. Provide and install complete and operational Video Surveillance System (VSS) and or Closed-Circuit Television (CCTV) System as outlined in these specifications and related drawings and documentation requirements as set forth within this documentation.
   2. It is the responsibility of the Contractor to provide all wiring, plates, connections, and miscellaneous equipment for complete and fully operational system even if specified in this or other related documents or not.
   3. Included spaces / systems
      a. Include list of spaces / buildings here!
      b. Interior IP Cameras
      c. Outdoor IP Cameras
      d. Recording and IP camera monitoring
      e. Network switch(s) for IP camera connectivity.
      f. H.264 / H.265 video server and storage array.

B. Coordination, provision, installation, inspection, testing, instruction, and warranties of the VSS and or CCTV systems.

C. All facilities, materials, equipment, transportation, and necessary labor for a complete and operational VSS and or CCTV system.

D. Additional contractor requirements:
   1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
   2. Verification of dimensions and conditions at the job site.
   3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturer's recommendations.
   4. Submittal information and provisions.
   5. Documented Camera System testing procedures.
   6. Instruction of operating personnel.
   7. Manuals and provisions thereof.
   8. Maintenance and warranties.

1.3 RELATED DOCUMENTS

A. General: Comply with all Contract Documents, including Divisions 0, 1, 15, 26, 28, and the general contract specifications.

B. Related specification sections:
   1. Section 28 13 00 - ALARM & ACCESS CONTROL
   2. Section 28 05 28 - CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

1.4 RELATED WORK

A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.

B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
   1. Section 07 84 00 - FIRESTOPPING
   2. Section 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
   3. Section 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
   4. Section 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
   5. Section 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

1.5 DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
   1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
   2. The terms "shall" is mandatory, "will" is informative, and "should" is advisory.
   3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
   4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
   5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
   6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
   7. The term "Professional grade" – Equipment that is intended for commercial use, use and is rated for continuous 24-7 use.
   8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
   9. The term "Labels" – refer to labels on audio-visual equipment as outlined in Section 3.4.
   10. The abbreviation "OFE" refers to items that are Owner Furnished Equipment
   11. The abbreviation "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment
   12. The abbreviation "VSS" refers to video surveillance system.
   13. The abbreviation "CCTV" refers to closed circuit television camera systems and components.
   14. The abbreviation "ALM" refers to an integrated alarm system and components.
   15. The abbreviation "ACS" refers to an integrated access control system and components

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS / CODES

A. Applicable Codes and Standards:

1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
   a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
   b. International Building Code / BOCA National Building Code
   c. National Electrical Code (NEC)
   d. American Standards Association (ASA)
   e. Electronics Industries Association (EIA)
   f. Institute of Electrical and Electronic Engineers (IEEE)
   g. National Electrical Manufacturers Association (NEMA)
   h. Occupational Safety and Health Administration (OSHA)
2. National Fire Protection Agency NFPA
   a. NFPA-70 National Electric Code in particular the following sections:
   b. Sect 300: Wiring in ducts plenums, and other air handling spaces
   c. Sect 318: Cable trays
   d. Sect 645: Electronic Computer / data processing equipment.
   e. Sect 760: Fire protection signaling system
   f. Sect 770: Optical fiber cables
   g. Sect 780: Closed-Loop and programmed power distribution
   h. NFPA-71 Installation, Maintenance and use of Signaling Systems for Central Station Service.
   i. NFPA-72 National Fire Alarm and Signaling Code
   j. NFPA 72-D - Installations, Maintenance and Use of Proprietary Protective Signaling Systems
   k. NFPA 75 Protection of Electronic Computer Data Processing Equipment
   l. NFPA 262: Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
3. IEEE
   a. IEEE 802.3: STANDARD FOR LOCAL AREA NETWORKS
4. Underwriters Laboratories (UL)
   a. UL Listed- Underwriter's Laboratories Listed
   b. UL 83: Thermoplastic-Insulated Wires and Cables
   c. UL 294: Access Control System Units / ULC Standard for Access Control Systems
   d. UL 611: Central Station Burglar Alarm Units and Systems
   e. UL 634: Standard for Connectors and Switches
   f. UL 639: Standard for Intrusion Detection Units
   g. UL 1076: Proprietary Burglar-Alarm Units and Systems
   h. UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
   i. UL 1635: Standard for Digital Alarm Communications System Units.
   j. UL 1655: Standard for Community-Antenna Television Cables
   k. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
   l. UL 1950 Information Technology Equipment, including Electrical Business Equipment
5. ANSI / TIA / EIA:
   a. ANSI C2: NATIONAL ELECTRIC SAFETY CODE

b. ANSI X3T9.5 STANDARD FOR FIBER DISTRIBUTED DATA INTERFACE (FDDI)
c. TSB-67: TRANSMISSION PERFORMANCE FOR FIELD TESTING OF UTP CABLING SYSTEM
d. TIA-222 STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS
e. EIA 232-D Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Serial Binary Data
f. EIA RS-310-C Racks, Panel, and Associated Equipment
g. TIA-455-78 Revision B, FOTP-78 IEC 60793-1-40 Optical Fibers - Part 1-40: Measurement Methods and Test Procedures – Attenuation
h. TIA 568-B.1-2000 Telecommunications Standard
i. TIA-568-C.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS
j. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
k. TIA / EIA: 606a Telecommunications Infrastructure Standard
l. TIA / EIA: 607 Grounding and Bonding Requirements
m. EIA/CEA: 861 A DTV Profile for Uncompressed High-Speed Digital Interfaces.
n. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History

6. Video Coding Experts Group VCEG
   a. H.262[1] or MPEG-2 Part 2
   b. H.263
   c. H.264/MPEG-4 AVC
   d. H.264 or MPEG-4 Part 10
   e. H.265 or High Efficiency Video Coding (HEVC),
7. References to codes and standards called for in the Specifications refer to the latest edition, amendments, and revisions to the codes and standards in effect on the date of these Specifications.

1.7 SCOPE OF WORK REQUIREMENTS

A. The Contractor shall provide a VSS and or CCTV System compatible with the Owner's existing systems and operations as applicable.

B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.

C. The Contractor shall provide a complete and operational system configured and installed for user-friendly operation and low maintenance.
   1. Provide one adjustment and calibration of the VSS and or CCTV systems, as directed by the Owner's Representative, before Final Acceptance.
   2. Provide one adjustment and calibration of the VSS and or CCTV systems, as directed by the Owner's Representative, after Final Acceptance.

D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.

E. The contractor shall restore finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.

F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.

G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.

H. All finalized software affiliated with the equipment, including but not limited to, the DSP, Control System, etc. is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.

I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM DESCRIPTION AND REQUIREMENTS

A. The following is for a basic system description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.

B. The VLS and or CCTV System for the Location makes up the security hardware/software portion of the client's programmatic use requirements. The Security System will be a state-of-the-art system designed to comply with the requirements for video surveillance systems.

C. Materials:
   1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
   2. The following list of main items of the installation shall not be considered to be all-inclusive:
      a. Cameras fixed indoor and outdoor
      b. All power supplies and transformers.
      c. Master Deck, or work station.
      d. Computer(s)
      e. Camera control software
      f. Camera control surface.
      g. Wire for cameras and network communications connections.
      h. Provide indoor fixed view IP cameras with PoE connectivity. (CAM1/CAM2)
         1) Provide mounts and hardware as required.
      i. Provide outdoor wall mounted IP cameras with PoE connectivity. (CAM3)
         1) Provide mounts and hardware as required.
      j. Provide Video Management Software (VMS)
         1) Provide interface for viewing of cameras from both PCs and from portable devices.
         2) Provide live monitoring and camera controls.
      k. Provide all power supplies and transformers as required.
      l. Computer(s)

m. Camera control software and network IP interface
n. Wire for cameras and network communications connections.

D. System Description:
1. The VSS and or CCTV System is a building wide camera system with motion detection cameras installed in the various areas as located on the drawing plans. The same camera system shall be utilized in both indoor and outdoor cameras. The outdoor cameras shall be mounted in such a way as to allow proper site lines for coverage of the outside perimeter of the building and the main entry points into the building, yard, and entrance ways. The camera system shall allow for expansion beyond the camera capacity as shown on the drawings and shall allow easy user interfacing for camera control. All cameras shall be a fixed unit. All fixed cameras shall be IP. See drawings for camera locations.
2. The video cameras will be connected to the building IT network. The cameras will be controlled via an VSS and or CCTV management system and use NVR or video recorders.

1.9 RELATED WORK

A. Conduits:
1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.

B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.11 SCHEDULING

A. The Contractor shall submit a schedule to the Owner for approval. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off of project. This schedule shall be submitted on Microsoft Project, both paper and electronic format, with submittals.

B. It shall be the responsibility of the Contractor to coordinate the installation of the system to be compatible with the work of the other trades. The Contractor shall attend weekly progress meetings and provide continuous on-site project management.

C. It shall be the responsibility of the Contractor to arrange with the Owner a mutually acceptable time for Acceptance Testing, based upon the dates provided in the Solicitation.

1.12 PROJECT SCHEDULE

A. A (mandatory) pre-bid site visit on, DATE at TIME will be utilized to allow the Contractor to review the current jobsite conditions and define special requirements.

B. All Requests For Information (RFIs) shall be directed to the Consultant and should be received by Close of Business (COB) on DATE.

C. All bids must be received at the Warrenton office of Polysonics to the attention of the Consultant. All bid proposals (electronic copy) are due to Polysonics no later than TIME on DATE.

D. Hard copies of the bid proposals will be accepted by TIME on DATE.
   1. Please provide bid submission per project bid instructions.

E. The opening of the bid proposals will be held between Polysonics and the Owner's Representative, with no bidder's present.

1.13 BID/TECHNICAL PROPOSALS

A. The VSS and or CCTV System Installer shall be experienced in the provision of systems similar in complexity to those required for this [project and shall at least meet the following criteria:
   1. The primary business of the Contractor/Installer shall be the installation of VSS and or CCTV systems.
   2. At least five (5) years' experience with the specified equipment and systems.
   3. Experience with at least one project of similar size and complexity as outline in these specifications.
   4. Be an authorized dealer and service facility for the products specified and furnished.
   5. The Contractor shall provide personnel with extensive training for each system type and configuration.
   6. The Contractor shall maintain a fully staffed installation crew and service crew for maintenance and installation of the specified systems.
   7. Lead Installer shall have factory training in support of installed systems and equipment.
   8. Contractor shall demonstrate that the installation staff consists of certified security professionals.
   9. Final VSS and or CCTV System configurations shall be approved by the Owner's Representative, Architect and Consultant.
   10. At the request of the Owner, Contractor shall demonstrate that he has:
      a. Sufficient facilities and equipment for this work.
      b. Sufficient staff with the appropriate technical expertise and experience for this project.
   11. All Bid proposals shall be valid for ninety (90) days from date received.
   12. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment

B. Provide a list of five (5) references with locations, names of contacts, and contact phone information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old.

C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents, drawings, manufacturer requirements, and pre-bid RFI responses as applicable.

1.14 PRE-BUILD AND FINAL SUBMITTALS

A. Provide the following for approval sixty days after Notice to Proceed and prior to commencement of work:
   1. A complete list of all products to be incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
   2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
   3. Provide shop drawings as defined in the section below.

B. Shop Drawings:
   1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of systems.
   2. All drawings shall be scaled appropriately but not less than 1/8" =1'.
   3. Schematic detailed wiring diagrams showing interconnection of Contractor provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
   4. Show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling within housing.
   5. Show all A.C. power outlet locations and terminal strip locations within each equipment rack.
   6. Plans and sections of the building and adjacent grounds showing the location of all installed equipment such as loudspeakers, racks, consoles, plates/panels, antennas, (etc.).
   7. Patch panel layouts and labeling strips, including color schemes as necessary.
   8. Full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
   9. Provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate.
   10. Complete labeling schemes for all cabling and equipment components for the project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
   11. A complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout with a t least a 20% oversize for project utilization for future system growth.
   12. Provide a complete conduit riser and associated conduit plans for a complete conduit system. Include a Junction Box schedule showing type, size, mounting style, and location of each box.

C. Submittal Format: (PDF version)
   1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
   2. Separate major groupings Use multiple volumes / list of content
   3. Index product data sheets by manufacturer and model or part number.
   4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
   5. Reference addendum or change order numbers as applicable.
   6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.

7. Provide via pdf, posted to FTP, thumb drive and or CD / DVD ROM.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

D. Submittal Format: (Printed Option if specifically Required)
1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
6. Reference addendum or change order numbers as applicable.
7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information:
   a. Project title and number.
   b. Submittal number.
   c. Date of submission.

1.15 PROJECT CONDITIONS

A. Verify conditions on the jobsite applicable to this work. Notify Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.16 QUALITY ASSURANCE

A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.

B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating Integrated Security Video Surveillance Systems which include access control and alarm monitoring. Manufacture shall be able to similar installations rendering satisfactory service.

C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.
1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.

2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.17 PRE-INSTALLATION MEETING/SCHEDULE

A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.

B. A Conduit/Wiring Analysis shall be conducted at the Pre-Installation Meeting. The Contractor shall submit "as-built" drawings locating all existing conduit runs, junction boxes, and electrical outlets. Show location and type of all special receptacle boxes and plates to be supplied and/or modified by the Contractor. Verify and inspect all necessary conduits and outlets. Provide with the submittals, a list of all conduits, boxes, and power changes necessary for installation of systems in each location.

1.18 FINAL INSPECTION AND TESTING / COMMISSIONING

A. Upon completion of installation and Contractor testing and commissioning (as outlined in sections 3.6), the Consultant shall perform system(s) inspection and testing (as outlined in section 3.7).

B. To assist the Consultant by providing a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the system(s).

C. Process of testing the system(s) may necessitate moving and adjusting certain components such as camera aiming and or focus / iris adjustments.

D. Testing will include operation of each camera and sub system and any components deemed necessary. Provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.

E. In the event that further adjustments or work is required during testing, the Contractor shall continue his work until the system(s) is acceptable at no addition to the contract price. If approval is delayed due the defective equipment, and/or failure of equipment or installation to meet the requirements of this specification, the Contractor shall pay for additional time and expenses of the Owner at the rate specified by the Owner.

1.19 WARRANTY

A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to

meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial one-year service contract.

B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.

C. The Contractor shall respond with remedy to a trouble call within twenty-four (24) hours after receipt of such a call and shall provide a 24-hour service phone number. Uptime for system(s) shall be no longer than 24-hour period. All replacement parts/components shall be of equal or higher level for service.

D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

E. At least two routine inspection and adjustment visits will be scheduled for the first year. Submit reports to Owner.

F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.

1.20 INSTRUCTION OF OWNER PERSONNEL

A. After final inspection and completion, provide instruction to Owner designated personnel on the operation and maintenance of the system(s).

B. Develop an instructional course based on the use of the system(s) and manufacturer's recommendations. Provide a minimum of five (5) hours of instruction. Arrange course so that operational and maintenance classes are separate.

C. The training plan or class shall include detailed sections outlines and related reference materials. The Owner personnel shall be able to utilize these materials in the subsequent training of their co-workers.

D. Submit an outline of the course with sample instructional aids for approval thirty (30) days prior to scheduled instruction sessions.

E. The training time shall not be less than a total of 32 hours, and shall consist of:
   1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
   2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
   3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's telecommunications personnel**.**

F. The specified training schedule shall be coordinated with the Owner and will follow the training outline submitted by the Contractor as part of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electronic component models shall be commercially available for a least one (1) year prior to bid or be approved by the Consultant and or Owner's Representative.

B. All equipment and material shall be new unless otherwise noted in this specification.

C. All equipment must be UL listed or manufactured to meet or exceed UL standards, where required.

2.2 GENERAL

A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied, unless a variance (separate document) is submitted and approved by the Owner's representative and or Consultant.

B. System shall be installed and configured for simplicity of operation, with user-friendly controls.

C. Provide product quantity as required for a complete and operable system. If any quantities are given, the Contractor shall provide at least the given amount. Some of the product listed under this section may not be required to fulfill the work as outlined.

D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.

E. Remove all manufacturer's nameplates or logos from product, as required, within the public site lines or spaces.

F. Paint all wall and ceiling mounted devices as directed by the Consultant/Architect.

G. The Contractor is responsible for providing a fully operational turnkey system.

2.3 PRODUCTS

A. The quantities of components shall be determined and installed by the Contractor based on the requirement to provide a fully operational Integrated Security VSS and or CCTV System, as per the intent of the specification, and as shown on the drawings and recommended by the Manufacturer.

2.4 CAMERAS

A. Indoor Fixed IP Camera (CAM1)
   1. Image sensor: Progressive scan RGB CMOS 1/2.5"
   2. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles Motion JPEG
   3. Resolution: 3072x1728 to 160x90
   4. Frame rate: 25/30 fps with power line frequency 50/60 Hz
   5. Shutter time: 1/62500 s to 2 s
   6. Camera angle adjustment: Pan ±180°, tilt -40 to +75°, rotation ±95°

7. Minimum illumination: Color: 0.18 lux at 50 IRE, F1.7 B/W: 0.04 lux at 50 IRE, F1.7, 0 lux with IR illumination on
8. With wall mount bracket
9. Acceptable product:
   a. Axis P3227-LVE

B. Indoor Fixed IP Camera (CAM2)
1. Image sensor: Progressive scan RGB CMOS 1/3"
2. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles Motion JPEG
3. Resolution: 3072x1728 to 160x90
4. Frame rate: With WDR: 25/30 fps with power line frequency 50/60 Hz Without WDR: 50/60 fps with power line frequency 50/60 Hz
5. Shutter time: 1/66500 s to 1 s
6. Camera angle adjustment: Pan ±180°, tilt -35 to +75°, rotation ±95°
7. Minimum illumination**:** HDTV 1080p 25/30 fps with WDR - forensic capture and Lightfinder: Color: 0.16 lux at 50 IRE, F1.4 B/W: 0.03 lux at 50 IRE, F1.4, 0 lux with IR illumination on HDTV 1080p 50/60 fps: Color: 0.32 lux at 50 IRE, F1.4 B/W: 0.06 lux at 0 IRE, F1.4, 0 lux with IR illumination on
8. With wall mount bracket
9. Acceptable product:
   a. Axis P3227-LVE

C. Outdoor fixed IP Camera (CAM3)
1. Image sensor: Progressive scan RGB CMOS 1/2.5"
2. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles Motion JPEG
3. Resolution: 3840x2160 to 160x90
4. Frame rate: 25/30 fps with power line frequency 50/60 Hz
5. Shutter time: 1/62500 s to 2 s
6. Camera angle adjustment: Pan ±180°, tilt -40 to +75°, rotation ±95°
7. Minimum illumination: Color: 0.19 lux at 50 IRE, F1.7 B/W: 0.04 lux at 50 IRE, F1.7, 0 lux with IR illumination on
8. With wall mount bracket
9. Acceptable product:
   a. Axis P3228-LVE

2.5 NETWORK DEVICES

A. Server configured with Video Management Software: VMS
1. Provides live monitoring and camera controls
2. Integrate with access control systems (ACS)
3. Audio and video playback and recording
4. 64-bit architecture
5. Simple and easy to use
6. Legacy camera support
7. Apps for apple and android devices.
8. Web interface
9. Multi setup and layouts based on access permissions.

10. Acceptable product:
    a. TBD

B. Network switch(s)
1. 24 Port Gigabit Network Switch
2. Optimized for H.264 / H.265 unicast and multicast streams.
3. Ethernet AVB support: 802.1ak - Multiple Registration Protocol (MRP/ MMRP). 802.1AS - Timing and Synchronization for Time Sensitive Applications in Bridged Local Area Networks (PTP). 802.1Qat - Stream Reservation Protocol (SRP) 9 802.1Qav - Forwarding and Queuing Enhancements for Time-Sensitive Streams. 802.1AB-REV - Station and Media Access Control Connectivity Discovery (LLDP)
4. 2 Gigabit Interface Converter (GBIC) slots for optional fiber connectivity
5. Smart Control Center utility program automatically discovers devices
6. Administrative management via web-browser interface: Port configuration. Port monitoring. Port trunking. VLAN support. Class of Service (CoS). Layer 2 management. MAC address Filter. Ethertype Filtering Plug-and-play networking
7. Configured with PoE
8. Two SFP slots with fiber modules, provide fiber connectivity between AV network switches to allow for high bandwidth to support audio and streaming video connectivity.
9. Configured with V-lan to support control, AVB, and Streaming network traffic
10. Acceptable product:
    a. TBD
    b. Or approved equal

C. H.264 / H.265 video server and storage array.
1. Scalable design and configuration
2. Supports advanced camera features
3. Provides IP Load balancing
4. All settings are stored database
5. Uses IIS for web access
6. SQL server based
7. Supports cameras up to 20 MP resolution
8. Automated failover functions
9. Processes unattended rules and alarms
10. Users login to any server, no single point of failure
11. Supports 3,000 cameras from over 100 manufacturers
12. Supports camera- and server-side motion detection
13. Support for all storage
14. AD/LDAP active authentication
15. Designed for multi-server, multi-location, large camera deployments
16. Server shall be optimized for H.264 / H.265 unicast and multicast streams in either 720P or 1080P resolutions.
17. Drive Bays Up to sixteen 3.5" drives, two 2.5" drives
18. Chipset Intel® C610
19. Graphics Card 2D Matrox® G200 Integrated
20. I/O Slots 6x PCIe slots
21. Operating System Windows 2008 Server (WinSer 2012 upon request)
22. Optical Drive DVD+/-RW

23. Power Supply Dual, Hot-plug, Redundant Power Supply, 750W
24. Processor 2 x Intel® Xeon® Processor E5-2603 v3 1.6 HGZ, 15M Cache
25. RAM 8 GB
26. RAID Configuration OS (2, 500GB drives RAID 1), Storage configured in RAID 5 or RAID 6 (for 14 or more drives)
27. RAID Controller Perc H730 Integrated RAID Controller
28. Total Storage 96 TB
29. Network Controller Broadcom 5720 QP 1GB Network Daughter Card
30. Memory Up to 765GB (24 DIMM slots) 4GB/8GB/16GB/32GB DDR4 up to 2133MT/s
31. Cloud storage of camera and access information for up to 6 months.
32. Acceptable product:
    a. TBD
    b. Or approved equal

2.6 PLATES AND PANELS

A. Provide plates and panels as described in the drawings and as required for a fully operable system.

B. Custom plated shall be 1/8" thick aluminum, standard EIA sizes, brushed black anodized finished unless otherwise noted.

C. Plastic plates are not allowed.

D. Lettering shall be in all caps and numbers engraved with a color contrasting to the base material with a minimum size of 0.25".
   1. Font Size shall be 1/8"
      a. Font Style shall be Helvetica

E. Acceptable manufacturers of custom plates and panels:
   1. RCI Custom
   2. Panel Authority
   3. Whirlwind

2.7 PROPOSED SUBSTITUTIONS

A. Where specific equipment is described, it is not the intention to discriminate against the products of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.

B. The Owner's Representative and or Consultant requires manufacturer's original specification tests. The Owner's Representative and or Consultant will evaluate and approve/disapprove all substitutions.

C. Items designated "no substitutions" shall be that specified item only. Submission of items other than specified shall not be considered and may disqualify RFP submission.

2.8 CABLES AND WIRING

A. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

B. Plenum Rated / Non-Plenum Ratings: Cable routed in conduits and or equipment racks can have non-plenum rated (PVC) jacket. All other cables shall have a plenum or riser rated jacket compliant to the cable run and purpose. Cable runs shall be continuous without splices.

C. Cable Selection: Based on signal type as indicated on single line diagram, noted at equipment input, or output connection type. Wire manufacturer and part numbers are provided as a basis of cable quality and signal characteristics. Alternate cable manufacturers to be requested for approval during pre-build submittal.

D. Provide cabling compliant with Section 28 05 13 - CONDUTORS AND CABLES FOR ELECTRONIC SAFETY

E. Provide the following cabling types as required by equipment manufacturers guidelines for a fully operable system:
   1. Communication outlet cables: 18 AWG 2 conductor shielded – West Penn 293
   2. Control cables: 18 AWG 2 conductor shielded – West Penn 293
   3. Antenna / CATV cable: RG-6 Quad Shield minimum refer to FCC / Cable provider recommendations as required.
   4. Precision video cable: Belden 8281 as required.
   5. Trunk video cable (RG6): West Penn Wire 841 (S).
   6. Trunk video cable (RG11): West Penn Wire 821.
   7. Video drop cable (RG6 Plenum): West Penn Wire 25841.
   8. Trunk video cable (RG11 Plenum): West Penn Wire 25821.
   9. 9-conductor 22AWG. Communications cable: Belden 9945.
   10. 9-conductor 18AWG. Communications cable: Belden 83659.
   11. Unshielded Twisted pair Category 5e Cabling West Penn Wire 254245
   12. F/UTP Category 6 Cabling West Penn Wire 254246AF
   13. Shielded Twisted pair HDBaseT Cabling Extron XTP DTP 24

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing.

B. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.

C. Units shall be installed parallel and square to building lines. All wires shall be gathered and fastened to create an orderly installation.

D. Electronic equipment shall be permanently mounted in equipment racks or as applicable to the equipment and application.

E. Contractor shall mount all equipment, mounting brackets, plates and panels, plumb and level.

F. Contractor shall follow all applicable standards including ASIS Commission on Standards and Guidelines documentation as a basis of design, fabrication, construction, and Performance Verification.

G. Contractor shall provide shaft locks or security covers on non-user operated equipment having front panel access.

H. Contractor shall permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.

I. Contractor shall validate bracing or blocking for proper mounting and safety.

J. Contractor shall provide seismic bracing for appropriate equipment where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 EQUIPMENT HOUSING

A. Equipment Enclosures / Racks:

1. Install all applicable equipment in racks and or wall mounts according to manufacturer's recommendations and product application.
2. Provide adequate ventilation, thermal management and temperature-controlled fans to maintain a rack temperature of less than 85 degrees Fahrenheit.
3. Provide rear support and rear rack rails for housing mounted equipment greater than 15" deep.
4. Allow a minimum of 20% open rack space to support future expansion.
5. Fill all empty spaces with blank panels, sizing as required; painted and or anodized to match housing.
6. Locate operator useable equipment and patch panels at an appropriate operating height.
7. Key all door locks for each housing type (front, rear) alike.
8. Looking at the equipment racks from the rear of the racks, install all AC power and ground cabling on the left and audio and video cabling on the right.
9. Provide LED lights mounted in the top of every two racks to illuminate the interior for service or maintenance. LED lights shall be individually switch-able and placed so as to provide maximum illumination throughout the rack.
10. Dress all loose cabling for a clean and orderly rack. The use of electrical tape for cable management is prohibited.
11. The use of tie wraps for network UTP, STP, and optical fiber cabling is prohibited.
12. Provide nylon braded sleeving for wiring harnesses for a clean installation of cabling that is visible to user areas. Sleeving color shall be coordinated with location and device color.

3.3 PATCH PANELS

A. Video Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tie-lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any console connections and interconnection of rooms and equipment.

B. Unshielded Twisted Pair UTP / STP RJ-45 Patch Panel Configuration:
   1. Patch panel shall be located in designated racks as shown on drawings.
   2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
   3. Configure and terminate patch bay per TIA / EIA standards.

3.4 LABELING

A. Device Labeling:
   1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
   2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

B. Rack Labeling:
   1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
   2. All rack panel labeling shall be engraved and filled.

C. Wire and terminal strip labeling:
   1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
   2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
   3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
   4. Wiring designator shall be alphanumeric code, unique for each cable.
   5. Each cable type shall be labeled starting with different destinations (i.e. Camera series "Cxxx", / Low voltage Power series "LPxxx", etc.).
   6. On projects that have multi room connectivity the source and destination room numbers should be a part of the cable number indicting a cable that traverses between two rooms.
   7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.5 PERFORMANCE STANDARDS

A. All provided devices / equipment shall meet and or exceed published manufacturer's specifications and be compliant with the outlined salient capabilities as described in section 2 and be compatible with all applicable standards and configurations.

3.6 CONTRACTOR TESTING AND OR COMISSIONING

A. Prior to energizing or testing the system, ensure the following:
   1. All products are installed in a proper and safe manner per the manufacturer's instructions.

2. Insulation and shrink tubing are present where required.
3. Dust, debris, solder, splatter, etc. is removed.
4. Cables are dressed, routed, and labels and all connections are consistent with regard to polarity.
5. All labeling has been provided and installed.
6. All products are neat, clean, unmarred and securely fastened.
7. All debris has been cleaned and removed from the site.
8. All electronic devices are properly grounded.

B. Perform the following test. Record all results in the final project manual.
1. Test each AC power outlet for proper connections for hot, neutral and ground.
2. Measure and record the DC resistance for the supplemental ground in the equipment rooms. Resistance should be 0.15 ohms or less.

C. Input Verification Test: (Composite video)
1. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
2. Composite video shall conform to all applicable NTSC standards.
3. Perform complete system operation to verify proper system operation.
4. In a similar manner, check any other inputs or tie-lines as appropriate.

D. Input Verification Test: (IP Cameras)
1. Verify video stream presence on network and verify resolution and color depth settings.
2. Configure IP address for each stream to multi-image processor and to recorder as specified.
   a. IP video shall conform to all applicable streaming media standards.
3. Perform complete system operation to verify proper system operation.
4. In a similar manner, check any other cameras or streaming devices as appropriate.

E. Notification:
1. Once all of the above is complete, the system is ready for inspection. Formally notify the Owner's representative and or consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and configurations will be conducted at the time of inspection.

3.7 CONSULTANT ACCEPTANCE TESTS

A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined within section 3.6 has been completed and the test results have been received and reviewed by the consultant and or owner's representative.

B. Consultant acceptance testing will be conducted based on applicable sections of the ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard.

C. Checklist items within this list will be verified by visual and or audible methods as part of normal use case operational scenarios, with the assumption that the contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per section 3.6 above.

D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
   1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
   2. The operation of all system equipment shall be demonstrated by the contractor.
   3. Contractor shall provide a laptop to support testing activities that is configured and connected to any and all control processors for any evaluation and adjustments (tuning) activities by the consultant.
   4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection / configuration.
   5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
   6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
   7. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the consultant.

E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION

SECTION 28 31 00
VOICE EVACUATION FIRE ALARM SYSTEM

1. GENERAL

A. SCOPE AND RELATED DOCUMENTS

(1) The work covered by and the intent of this section of the specifications includes the furnishing of all labor, equipment, materials, testing, programming and performance of all operations in connection with the installation of the Fire Alarm System as shown on the drawings, as herein specified and as required by the applicable codes.

(2) The requirements of all other applicable conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.

(3) The complete installation shall conform to the applicable sections of NFPA-71, NFPA-72A, B, C, D, Local Code Requirements and National Electrical Code (Article 760). The requirements of any local fire department and the Authority Having Jurisdiction shall also be observed in the system installation and device layout.

(4) The work included in this section shall be coordinated with related work specified elsewhere in these specifications.

B. QUALITY ASSURANCE

(1) Every component, device, transmitter, software, etc., that are included in the work, to make up a complete Fire Alarm System shall be listed as a product by the manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label.

(2) The system power, signal and controls wiring shall be UL listed for Power Limited Applications per NEC 760. All circuits shall be marked in accordance with NEC Article 760.

C. GENERAL

(1) Furnish and install a complete digital multiplex Voice Evacuation Fire Alarm System as described herein and as shown on the plans; to be wired, connected, completely tested, and left in first class operating condition. The system shall use individually-addressable digital multiplex device circuit(s) with individual device supervision, appliance circuit supervision, incoming normal and stand-by power supervision. In general, systems shall include a control panel, manual pull stations, automatic fire detectors, horns, flashing lights, annunciator (if indicated), raceways, all wiring, connections to devices, connections to valve tamper switches, water flow switches and mechanical controls, outlet boxes, junction boxes, and all other necessary materials for a complete, operating system. Reconnect to existing system device locations accordingly. Provide new devices accordingly if tie-in to existing manufacturer/system is not possible.

The fire alarm control panel shall allow for loading or editing of any special instructions or operating sequences as required. No special tools, modems, or an off-board programmer shall be required to program the system to facilitate future system expansion, building parameter changes, or changes as required by local codes. All instructions shall be stored in a resident non-volatile programmable memory.

(2) All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name of each component. Any catalog numbers specified under this section are intended only to identify the type, quality of design, materials, and operating features desired.

The listing of specific catalog numbers and equipment parameters is not intended to limit competition among other manufacturers that propose to supply equivalent equipment and services. Fire alarm systems as manufactured by Simplex, Siemens/Cerberus, Edwards, Thorn or Notifier will be acceptable.

(3) Equipment submissions for shop drawing review must include a minimum of the following:

a. Complete descriptive data indicating UL listing for all system components.

b. Complete sequence of operations of the system.

c. Complete system wiring diagrams for components capable of being connected to the system and interfaces to equipment supplied by others.

d. A copy of any state or local Fire Alarm System equipment approvals.

e. An Autocad (latest version) produced wiring diagram illustrating the basic floor plan of the building, showing all system wiring and equipment, as well as zoning boundaries and schedule of zone legends as intended to appear on annunciators. Provide three CD-Rom copies of as-built drawings and all system operational software at close of project, to be included in operation and maintenance manuals.

(4) No work shall be done until the drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

D. OPERATION

(1) The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:

a. 1) The appropriate initiating device circuit indicator (red color) shall flash on the control panel until the alarm has been silenced at the control panel. Once silenced, this same indicator shall latch on. A subsequent alarm received after silencing shall flash the subsequent zone alarm indicator on the control panel and resound alarms and flashing signals. These same conditions shall occur at any remote annunciator.

2) A pulsing alarm tone shall occur within the control panel until silenced.

b. All alarm indicating appliances shall sound in a temporal code pattern until silenced by an alarm silence switch at the control panel (or the remote annunciator, if any).

c. All doors normally held open by door control devices shall close. Doors shall also be released in the event of incoming normal power failure.

d. A supervised signal to notify the local fire department or an approved central station (as required by local codes) shall be activated.

e. A supervised signal shall directly activate, shut down or reconfigure the air handling systems as required by NFPA or as otherwise indicated herein. Provide necessary interlock wiring as required to control mechanical equipment..

f. The Contractor(s) shall coordinate with each other as necessary to provide all required auxiliary contacts, DDC systems interfaces, equipment, etc., as needed to shut down or otherwise control air handling systems per NFPA and all applicable codes.

g. The system shall be wired with two circuits to all Notification devices so that when an alarm is acknowledged, silencing the audibles, the visual units shall continue in operation until the main control panel has been reset. If local codes require other than this arrangement, the system shall be wired in accordance with the code that is applicable.

(2) The alarm indicating appliances shall be capable of being silenced only by authorized personnel operating the alarm silence switch at the main control panel or by use of a similar key operated switch at the remote annunciator (where remote units are provided). A subsequent alarm shall reactivate the signals. Operation of the alarm silence switch shall be indicated by trouble light and audible signal.

(3) The alarm activation of any elevator lobby shaft, pit or equipment room smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:

a. If the alarmed detector is in any location or on any floor other than the main level of egress, the elevator cars shall be recalled to the main level of egress.

b. If the alarmed detector is on the main egress level elevator lobby, the elevator cabs shall be recalled to the pre-determined alternate recall level.

c. Provide auxiliary contacts within the base of each elevator lobby smoke detector, with each separate landing to be wired back separately to the elevator controller. Coordinate all equipment terminations and sequence of operation with the elevator installer. The use of digital to analog controllers to accomplish this function will be acceptable, if in compliance with codes.

d. Provide heat detectors within 12" of each sprinkler head where they are installed in elevator equipment rooms, shafts or pits, in accordance with code. The temperature rating and wiring of the detectors shall be coordinated with the sprinklers, per ANSI Elevator Code and NFPA. Wire to interrupt elevator power per the applicable code.

(4) The activation of any standpipe water valve tamper switch or sprinkler zone valve tamper switch shall activate a distinctive system supervisory audible signal and illuminate a "Sprinkler Supervisory Tamper Switch" indicator at the system controls (and the remote annunciator[s]). There shall be a distinction in the audible trouble signals between valve tamper switch activation and opens or grounds on fire alarm circuit wiring.

a. Activating the trouble silence switch will silence the supervisory audible signal while maintaining the "Sprinkler Supervisory Tamper" indicator showing the tamper contact is still activated.

b. Restoring the valve to the normal position shall cause the audible signal and visual indicator to pulse at a fixed rate.

c. Activating the trouble silence switch shall silence the supervisory audible signal and restore the system to normal.

(5) Include with the control panel, as an auxiliary function, a built-in test mode that, when activated, will cause the following operation sequence:

a. The city connection circuit shall be disconnected.

b. Control relay functions shall be bypassed.

c. The control panel shall show a trouble condition.

d. The panel shall automatically reset itself.
e. Any momentary opening of an initiating or indicating appliance circuit shall cause the audible signals to sound for a minimum of two seconds to indicate the trouble condition.

(6) A manual evacuation switch shall be provided to operate the system indicating appliances and/or initiate "Drill" procedures.

(7) Activation of an auxiliary bypass switch shall override the automatic functions either selectively or throughout the system and initiate a trouble condition at the control panel.

(8) Include any and all detection equipment and interface relays as required to provide a 100% code approved and supervised pre-action Fire Suppression system. Coordinate with the Fire Protection installer as required.

E. SUPERVISION

(1) The system shall contain Class "B" (Style "B") independently supervised initiation circuits as required for the zoning indicated. Circuits shall be arranged so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

(2) There shall be supervisory initiation circuit(s), as required, for connection of all sprinkler valve tamper switches. Wiring methods which require any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e., sprinkler and standpipe tamper switches (N/C contacts) shall NOT be connected to circuits with fire alarm initiation devices (N/O contacts). These independent initiation circuit(s) shall be each labeled "Sprinkler Supervisory Tamper Switch" and shall differentiate between tamper switch activation and wiring faults. Provide individual annunciation for the main post indicator valve and each tamper switch as indicated by the zoning schedule on the plans or as otherwise required by codes. For these circuits and all exterior underground copper circuit wiring, provide proper surge suppression and protection for circuit.

(3) There shall be independently supervised and independently fused indicating appliance circuits as required for alarm audible signals and flashing alarm lamps.

(4) All auxiliary manual controls shall be supervised so that all switches must be returned to the normal (automatic) position to clear system trouble.

(5) Each independently supervised circuit shall include a discrete (amber color) "Trouble" indicator to indicate disarrangement conditions, per each circuit.

(6) The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel and the annunciator. A green color "power on" indicator shall be displayed continuously while incoming power is present.

(7) The system batteries shall be lead-acid type, supervised so that disconnection or failure of a battery shall be audibly and visually indicated at the control panel (and the annunciator).

(8) Wiring to a remote annunciator (if provided for system) shall be supervised for open and ground conditions. An independent annunciator trouble indicator shall be activated and an audible trouble signal shall sound at the control panel.

F. POWER REQUIREMENTS

(1) The control panel shall receive 120 VAC power via a dedicated circuit. The incoming circuit shall have suitable overcurrent protection within the control panel, as well as at the circuit source. If additional circuits are required for this or other control units, they shall be provided by the Contractor.

(2) If the facility is equipped with an emergency standby power generator, the fire alarm equipment shall be connected to this system, per N.E.C.

(3) The system control panel and auxiliary equipment, such as power supplies shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of time as required by codes for the building occupancy. There shall be reserve battery capacity to drive all alarm appliances for five minute indication at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operating shall be automatic. Batteries, once discharged, shall recharge at a rate that will provide a minimum of 70% capacity in 12 hours, or sooner if required by codes.

(4) All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

(5) Power supplies for Notification signals, whether in the main panel or within remote power supply cabinets, shall be designed to provide a minimum of 20% spare capacity for future signals.

G. FIRE ALARM CONTROL PANEL

(1) Where shown on the plans, provide and install the Fire Alarm Control Panel. Construction shall be modular with solid state, microprocessor based electronics. All visual indicators shall be high contrast, light-emitting diode type.

(2) The control panel shall contain the minimum following features as per plans:

- Minimum Capacity of 120 Control or Monitor Points or greater, to Suit Building Requirements, expandable to 1000 points
- Initiation Device Circuits
- Alarm Indicating Appliance Circuit
- Supervised Annunciator Circuits
- Local Energy City Connection, if required
- Form C Alarm Contacts (2.0 Amps ea., minimum of two unless otherwise required)
- Earth Ground Supervision Circuit
- Automatic Battery Charger, of proper rating
- Standby Battery, Lead/Acid Type
- Resident non-volatile programmable operating system for all operating requirements
- Supervised Manual Evacuation Switch
- Internal power supplies as required for auxiliary functions as indicated
- Auxiliary contacts or relays for auxiliary functions as indicated
- All Custom Software and Programming as required to suit the project requirements

H. SYSTEM SOFTWARE AND PROGRAMMING

(1) Provide all programming and software necessary to place annunciators and controls in full operation. System set-up shall allow for changes in annunciator legends without rewiring or addition of programming or electronics. Furnish initial programming and reprogramming as needed to accommodate changes in the system up to the time of system acceptance by the engineer without extra charge.

I. REMOTE ANNUNCIATOR

(1) Where indicated on the plans, provide and install annunciator/control panel. The panel shall be of vandal-resistant construction and shall contain a liquid crystal illuminated display for alphanumeric indication of all required functions. The panel shall also contain the following control functions, activated by a master system enable key switch on front panel:]

a. Remote system reset switch, to complement main control panel reset switch.

b. Remote alarm signal silence switch.

c. Remote manual evacuation switch, to initiate fire drill functions, same as at main control panel.

d. Remote trouble silence switch to silence trouble alarms in annunciator panel and main control panel.

e. Install panel on properly sized outlet box, 54" AFF to centerline. Panel shall contain tamper-resistant LED test switch in panel, local audible alarm, system power on, trouble LED indicators and master system enable key switch, keyed alike with the main control panel.

(2) Annunciator legends shall be custom, to display both zone number and brief legend indicating the area or device associated with that zone. The legends shall be electronically generated on an alphanumeric display panel. The fire alarm system vendor shall coordinate the legends with the Engineer at shop drawing review.

(3) Wiring between main control panel and annunciator(s) shall be fully supervised, and accomplished over twisted shielded pair and/or THWN wiring as required by the manufacturer, per N.E.C. and NFPA.

J. PERIPHERAL DEVICES

Note: On fully digital multiplex systems, provide addressable devices, bases or modules for devices listed herein. Each device shall be an individual address on the system. Addressable bases or modules shall be U.L. listed for the device served.

(1) MANUAL PULL STATION

a. Manual stations shall be double action and shall be constructed of high impact, red lexan or cast metal with raised white lettering and a smooth high gloss finish. The manual pull station shall have a hinged front with key lock. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock open in a protruding manner. Furnish one key for each manual station to owner at close of project, during instruction period. Install within 60" of each exit, per code, whether indicated on the drawings or not.

(2) CEILING-MOUNTED SMOKE DETECTORS, PHOTOELECTRIC TYPE

a. Furnish and install where indicated on the plans or required, ceiling-mounted smoke detectors. Provide separate outlet-box mounted base with auxiliary relay, or standard base, as required.

b. Smoke Detectors shall be listed to U.L. Standard 268 and shall be compatible with their control equipment. Detectors shall be listed for this purpose by Underwriters' Laboratories, Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. Loss of the operating voltage shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Detectors shall be capable of being reset at the main control panel.

c. No radioactive materials shall be used. Detector construction shall provide mounting base with twist-lock detector head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-cleaning contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide full solid state construction, and compatibility with other normally open fire alarm detection loop devices such as heat detectors, pull stations, etc.

d. To minimize nuisance alarms, voltage and RF transient problems, suppression techniques shall be employed as well as a smoke verification circuit and an insect screen. The detector head shall be easily disassembled to facilitate cleaning.

e. Remote LED alarm indicators shall be installed where required.

f. Smoke detectors (and all other system electronics) shall be shielded to protect circuitry from EMI problems generated by power fields, cellular phones, etc.

g. Special Note: The Contractor installing smoke detectors shall use care in the final positioning of all devices. They shall not be installed closer than 36" from an air diffuser or return grille, closer than 24" from a ceiling/wall intersection, or similar location that would diminish detector performance. Refer to and comply with NFPA 72E, "Standard On Automatic Fire Detectors".

h. Provide smoke detector at each fire alarm system control component, as required by code.

(3) AUTOMATIC HEAT DETECTORS (RATE-OF-RISE TYPE)

a. Automatic heat detectors shall be combination rate-of-rise and fixed-temperature type. When the fixed-temperature portion is activated, the units shall be non-restorable and give visual evidence of such operation. Heat detectors shall be 135, 165 or 195□F, as

indicated on plan. Where not indicated, provide 165º F units. Provide as indicated or required.

(4) AUTOMATIC HEAT DETECTORS (FIXED TEMPERATURE TYPE)

a. Where indicated on the plans, provide automatic heat detectors of the non-restorable type, of the temperature rating as indicated or required. Detector heads shall be mounted to an outlet-box mounted base. Provide auxiliary contacts as needed. Provide as indicated or required.

(5) AUDIBLE AND VISUAL UNITS

a. Audible signals shall be polarized and shall be operated by 24 VDC. Each audible assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors will not be accepted. The audible visual units shall be equipped with a xenon-type strobe which shall be semi-flush mounted on 4" square outlet box. Each audible device shall produce a minimum sound pressure level of 92db at 36" on axis. Provide units as manufactured by Wheelock, Inc., or approved equivalent. Locate as indicated or required. All audible tones for same function shall be identical, per NFPA. Provide sufficient audible units to comply with code for required coverage. Provide temporal coded signals.

b. The output intensity of all visual units, their locations and mountings shall be in compliance with the latest version of the Americans with Disabilities Act requirements.

c. Audible units and visual units shall be wired to separate Notification circuits, allowing for silencing of audibles with alarm acknowledgment, continuing operation of strobes until system reset. Addressable devices may be used to fulfill this requirement.

d. Provide system-wide synchronization of all visual devices, so that all strobes flash at the same rate and at the same time, complying with A.D.A.

(6) VISUAL UNITS

a. Stand-alone visual indicating units shall be xenon type strobe matching audio-visual units. These devices shall be UL listed and be or wall mounted. A high-impact clear lens shall project out from backplate. Lettering, if any, shall be oriented upright to the standing viewer. Candela output values of all visual units shall be selected for the covered spaces geometry and size, complying with A.D.A. and NFPA.

(7) DOOR HOLDERS

a. Magnetic door holders shall be 24 volt A.C., and shall have an approximate holding force of 25 lbs or greater, if required to restrain door. The door-mounted portion shall have a plated steel pivot mounted armature with shock absorbing bearing. Unit shall be capable of being either surface, flush, semi-flush or floor mounted as required. Door holders shall be UL listed for their intended purpose. Where door mounted, locate

armature 6" down from top and 6" in from strike side of leaf. Where door swing prevents direct contact between armature and holder pole piece, provide non-removable plated chain to close gap as tightly as possible. Verify holder positioning with Architect prior to mounting any devices. Unless otherwise indicated, provide semi-flush mounted holders 6" below top of door leaf as noted above, with blocking in wall to support force of door impact against holder and outlet box. Provide at all needed locations as indicated or required. Coordinate with architectural hardware schedule, as applicable to project.

(8) DUCT SMOKE DETECTORS

a. Duct smoke detectors shall be of the solid state photoelectric type, operating on the light scattering photodiode principle. The detectors shall ignore invisible airborne particles or smoke densities that are below the set alarm point. No radioactive materials shall be used. The basic construction of duct smoke detectors shall be the same as that previously described for ceiling-mounted smoke detectors. Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm status LED visible through a transparent cover, panel or in housing.

b. The Contractor shall furnish air duct smoke detectors with template to the sheetmetal or air handling unit installer for installation. Coordinate length of sampling probe required and furnish appropriate length. Probe tube shall be located in accord with manufacturer's recommendations, to give maximum sampling rate of airflow. Provide multiple detectors, as required, if a single device will not provide adequate sensing due to duct size or air velocity. Wire multiple detectors on a single air handling system as a single zone or address unless otherwise required by prevailing codes. Field verify quantity of detectors needed to provide NFPA-compliant coverage of the air handling unit and provide as required.

c. Detector supervised power and alarm wiring (from F.A. control panel) is to be provided by the Contractor. Interlock wiring from auxiliary contacts to stop or otherwise control air handling unit fan motor(s) is to be provided by the Contractor. Provide auxiliary contacts as required. Zone wiring and indication for air duct smoke detectors shall be maintained separate from area detection devices. Detector shall be capable of being reset at the main control panel, and at a local test/reset station.

d. Where air duct smoke detectors are located in other than Mechanical Rooms or in spaces not easily visible, a remote alarm/power indicating LED key reset station shall be installed. These remotes shall be ganged together, if required, and labeled accurately as to which unit is reporting an alarm condition.

e. Where air duct smoke detectors are indicated to be furnished at concealed air handling units above ceilings or smoke damper locations, furnish as outlined above. Also provide remote indicating alarm LED flush in corridor wall at 7'-0" A.F.F. immediately below installation, or as close as practical to installation. The Contractor is to provide control wiring, E.P. switches, etc., as required to operate smoke dampers, as well as the required operating circuit. Coordinate all requirements with the installer of smoke dampers.

f. Ionization - type detectors shall not be utilized for air duct smoke detection.

g. All air duct smoke detector installations and materials shall be in accord with U.L., NFPA, and any other applicable codes.

(9) WEATHERPROOF DEVICES AND EXPLOSION-PROOF DEVICES

a. Where the anticipated atmosphere or installation conditions require weather-proof, explosion-proof or other specially housed devices, they shall be U.L.-listed and NFPA-compliant and provided as indicated or required. Verify installation conditions and indicate type of device on shop drawing submission.

(10) END OF LINE RESISTOR

a. End-of-line devices (if required) shall be flush-mounted, located at 7'-0" A.F.F. in corridor walls or as indicated.

(11) GUARDS FOR DEVICES

a. Where detectors, manual stations, signals, etc., require or are indicated to be furnished with a guard, utilize a U.L. listed unit, compactly covering and compatible with the device. Provide as indicated or required. Guards shall not diminish the performance of any device.

(12) DIGITAL ALARM COMMUNICATOR/TRANSMITTER

a. Provide a U.L.-listed and NFPA-compliant digital alarm communicator/transmitter (D.A.C.T.). Install at telephone terminal board or telephone service entrance and provide supervised wiring to fire alarm control panel as required. This unit may be semi-flush mounted at the F.A.C.P. location with prior approval by the Engineer. It may also be integrated within the main control panel, if U.L.-listed for the purpose.

b. The installation and connection of the D.A.C.T. shall be in compliance with all provisions of N.F.P.A. 71 and all other applicable codes. The installation and connection shall be acceptable to the Authority Having Jurisdiction, as well as the telephone company (or companies) over whose lines the signal(s) will be transmitted. Include any costs associated with telephone company work and services required in bid. Telephone connection shall be in compliance with NFPA 71, chapter five.

c. The D.A.C.T. shall be capable of transmitting all information relative to system status changes due to alarm, trouble, water flow, and any other information as required by current codes applicable to the facility. This information shall be transmitted to a U.L. listed Central Receiving Station, that also is maintained in accord with the requirements of NFPA 71. Connect system to transmit signals as required by local codes.

d. As a part of this contract, the services of a Central Receiving Station shall be engaged for a period of one year from the date of substantial completion, this date as defined

elsewhere in these documents. The Central Receiving Station facility selected shall be in full compliance with NFPA and other applicable requirements. The Contractor shall initiate this service, provided on a contract basis, and shall include any costs associated with this provision in his bid. The actual beginning date of the contract with the central receiving station may be adjusted at the discretion of the Engineer, but in no case shall be for less than one year. The contractor shall notify the owner in writing by certified mail that this service has been contracted for and explain the provisions of this service adequately. A copy of this communication and the return receipt shall be forwarded to the Architect and the Engineer.

(13) REMOTE POWER SUPPLY UNITS FOR PERIPHERAL

a. Provide remote power supply(ies) as required for proper system operation.

b. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds and other supervisory functions.

c. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.

d. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.

e. Provide dedicated 120 volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

K. INSTALLATION

(1) Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be in a completely separate conduit system from power wiring or other raceway systems. Minimum conduit size shall be 3/4" trade size. Maximum wire fill shall be 40%, for any raceway system.

All junction boxes shall have coverplates painted red and labeled "Fire Alarm". A consistent wiring color code shall be maintained throughout the installation. The number of wiring splices shall be minimized throughout. Excessive wire splicing (as determined by the Engineer), shall be cause for rejection of the work.

(2) Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate tradesmen or other contractors.

(3) The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation.

(4) The manufacturer's authorized representative shall provide on-site supervision of installation, and shall perform the initial "power-up" of the system after he has thoroughly checked the installation.

(5) Operation and maintenance manuals submitted for this project shall list names, license numbers, and telephone numbers of at least two installers that are employed full time by the supplier/manufacturer to install and test fire alarm systems in the installation location.

A floor plan drawing indicating fire alarm devices and wiring only, shall be provided by the manufacturing company for job site use. These drawings shall be approved by the State Fire Marshal's Office or Local Authority Having Jurisdiction, as appropriate and in accord with code requirements. A copy of this drawing shall be submitted to the Engineer for his review, approval and project records.

L. TESTING

(1) The completed fire alarm system shall be fully tested in accordance with NFPA-72H by the contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the Contractor shall certify the test results in writing to the Fire Marshal, Owner, General Contractor, Architect and Engineer. Provide one week's written advance notice of the test to all concerned parties.

(2) All auxiliary devices the fire alarm system is connected to, including tamper switches, flow switches, elevator controls, remote receiving stations, etc., shall be fully tested for proper operation where interfacing with the fire alarm system.

(3) The Contractor shall provide a minimum of three hours of instructional time to the Owner in the operation and maintenance of all equipment and components. A receipt shall be obtained from the Owner that this has been accomplished, and a copy forwarded to the Engineer. Provide additional training time if required by the Owner at no charge to the contract or as direct charge to the Owner.

M. WARRANTY

(1) The Contractor shall unconditionally guarantee (except for vandalism or misuse) the completed fire alarm system wiring and equipment to be free from inherent mechanical, software and electrical defects for a period of one year from the date of substantial completion.

(2) The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72H guidelines.

END OF SECTION

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SECTION 31 10 00 - CLEARING

PART 1 GENERAL

1. 1 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to clear the project site.

1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving"

1.4 STANDARDS:

A. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.

1.5 PROJECT CONDITIONS:

A. Refer to Section 31 20 00 "Earthmoving", Section 31 20 05 "Building Earthwork", and as noted.

B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
   1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
   2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

1.6 SUBMITTALS:

A. Submit written notification to public utility companies, at least one week prior to planned work, for disconnection of active utilities.

1.7 DEFINITIONS:

A. Topsoil: A friable loam surface soil, free of subsoil, clay, lumps, weeds, roots, debris and stones exceeding one inch in any dimension.

1.8 CONSTRUCTION SURVEYS:

A. Provide survey equipment and qualified personnel for construction surveys. Provide stakes and/or flag trees to designate the limits of clearing operations.

PART 2 PRODUCTS:

2.1 TEMPORARY TREE PROTECTION FENCING:

A. In accordance with Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition, and as indicated.

B. Fence Posts: Steel "T" or "U" channel, with punched or riveted lugs for fence attachment.
   1. Weight: 1.33 pounds per linear foot
   2. Length: 66 inches
   3. Bottom End Shape: Pointed
   4. Finish: Rust inhibitive primer paint

C. Contractor's Option: Hardwood posts, two by two inches by 66 inches long, with pointed bottom ends.

D. Fence Fabric: Tensar Safety Barricade, manufactured by the Tensar Corporation, Morrow, Georgia.
   1. Fabric Height: Four feet
   2. Color: Safety Orange

E. Contractor's Option: Standard snow fence, used with steel posts.

PART 3 EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Trees: Protect existing trees, indicated "To Remain", and existing trees beyond the indicated "Clearing and Grading Limits" from the following:
   1. Cutting, breaking or skinning roots.
   2. Skinning or bruising bark.
   3. Stockpiling earth materials within drip line.
   4. Stockpiling construction materials within drip line.
   5. Vehicle parking within drip line.
   6. Excessive pedestrian or vehicular traffic.

C. Temporary Tree Protection Fencing: Provide "Temporary Tree Protection" for trees indicated to remain, and as required for existing trees beyond the indicated "Clearing and Grading Limits". Install as indicated or required in accordance with the standards of the "Maryland Standards and Specifications for Soil Erosion and Sediment Control", and as noted.
   1. Install posts, spaced no more than 6 feet on center, by driving plumb to 18-inch depth. Stretch fence fabric between posts and fasten securely to steel posts with tie wire. Fastenings for hardwood posts shall be tie wire or staples.

D. The Contractor shall provide a 'Watering Plan' submittal that identifies the frequency and rate of watering for review and approval. This will be required for all trees indicated "To Remain" during clearing and subsequent construction operations.

E. Repair or remove and replace trees indicated "To Remain" or located beyond the indicated "Clearing and Grading Limits" and damaged by clearing or subsequent construction operations, with new trees of equal species, caliper and quality, as directed by the Architect, at no increase to contract sum.

3.2 CLEARING:

A. Clear the project site, removing trees and vegetation, within "Clearing and Grading Limits" indicated.

3.3 GRUBBING:

A. Completely remove stumps, roots and debris, within "Clearing and Grading Limits" indicated, to minimum 12-inch depth below existing ground surface. Employ manual methods for grubbing around trees indicated "To Remain".

3.4 TOPSOIL STRIPPING:

A. Strip topsoil, within "Clearing and Grading Limits" indicated. Remove heavy vegetation growth before stripping. Strip topsoil to all depths encountered. Strip topsoil to prevent intermingling with tree roots underlying subsoil.
   1. Do not strip topsoil within the drip line of existing trees indicated "To Remain", or located beyond the indicated "Clearing and Grading Limits".

B. Stockpile topsoil, at locations approved by the Architect, until required for landscape development. Shape and grade stockpiles to prevent surface water ponding. Temporarily stabilize stockpiles as specified on the Soil Erosion and Sediment Control Drawings.

3.5 WASTE MANAGEMENT:

A. Transport combustible and non-combustible waste materials from the project site to legal offsite disposal areas. Document legal offsite waste disposal areas. Burning of waste materials is prohibited.

END OF SECTION

SECTION 31 10 05 - SITE DEMOLITION

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements, are a part of this section.

1.2 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", and Division 26 "Electrical".
B. Refer to Section 01 74 19 "Construction Waste Management and Disposal".

1.3 DESCRIPTION OF WORK:

A. This section specifies demolition of existing site improvements and underground utilities.

1.4 CODES:

A. For existing utilities refer to Section 31 20 00 "Earthmoving".

B. For existing flammable liquid storage tanks refer to National Fire Protection Association (NFPA).

C. Code of Maryland Regulations, Section 08.05.04; State of Maryland, Department of the Environment, Title 20, Subtitle 10, "Oil Pollution and Tank Management".

1.5 PROJECT CONDITIONS:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
   1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
   2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.
   3. Existing Subsurface Conditions: Verify existing pavement materials and respective thicknesses during prebid inspection. Obtain written authorization from the owner before conducting test hole explorations of existing pavements within the project site.

4. Traffic: Obtain written authorization from the local jurisdiction or adjacent property owners prior to obstructing vehicular traffic and parking areas. Obtain written authorization from local jurisdiction prior to obstructing public rights-of-way and easements.

5. Pre-bid Inspection Conditions: Conditions, existing during prebid inspections, will not be altered or modified.

1.6 SUBMITTALS:

A. Submit written notifications to public utility companies for disconnection of active utilities.

1.7 DEFINITIONS:

B. Demolition: Complete removal and disposal of existing facilities specified or indicated.

C. Salvage: Complete removal, by methods, which prevent damage or destruction of any items indicated to be relocated (or salvaged) and subsequent relocation and reinstallation in an area designated by Owner.

PART 2 PRODUCTS: (Not Used)

PART 3 EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Refer to Section 31 10 00 "Clearing" and Section 31 20 00 "Earthmoving".

B. Existing Facilities: Protect existing facilities and structures designated to remain, temporarily or permanently, from damage during demolition or construction activities. Repair items damaged during demolition or construction activities to their original condition, or replace with new. Do not overload structural elements or pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition and/or removal work. Repairs, reinforcement or structural replacement shall be approved by the Architect or the Owner's Representative.

C. Weather Protection: For portions of the existing building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of roofing or walls is necessary to accomplish work, immediately provide adequate temporary covering of exposed areas to assure protection of remaining facilities.

D. Existing Utility Services: The locations of underground utility services are approximate, and are taken from Owner's record information and record information provided by utility companies. Protect existing utility services designated to remain temporarily or permanently, or to

be relocated or removed by others. Contractor shall sequence demolition and construction activities to minimize utility service interruptions to existing facilities to remain. Where removal of existing utility services is required for other site construction, provide temporary covering of exposed areas, and temporary service or connections for utilities until permanent utility service replacements are completed.

1. Contractor shall coordinate with affected utility companies to determine extent of relocation work to be done by others.
2. Contractor shall coordinate utility relocation or removal by others with all phases of construction activity.

3.2 EXISTING SITE IMPROVEMENTS DEMOLITION:

A. Existing Pavements: Demolish existing pavements, regardless of pavement thickness, to limits indicated at no increase to contract sum. Neatly saw cut existing bituminous concrete pavement to straight, smooth and sharp edges perpendicular to pavement surface.

B. Existing Curbing: Demolish existing curbing to limits indicated, unless nearest expansion joint is less than six (6) feet from the indicated limits of removal. In that case, remove existing concrete curbing to the nearest expansion joint beyond the indicated demolition limits at no increase to the Contract Sum. Neatly saw cut existing Portland cement concrete curbing, to limits indicated, to smooth, clean and sharp edges perpendicular to top and face of curbing.
   1. Contractor's Option: Remove existing concrete curbing to nearest expansion joint beyond demolition limits indicated at no increase to contract sum.

C. Existing Entrances and Aprons: Demolish existing entrances and aprons indicated.

D. Miscellaneous: Demolish existing fencing indicated, including posts, footings and related appurtenances. Demolish additional miscellaneous existing site improvements indicated, specified and required to construct project.

3.3 MAINTENANCE:

A. Refer to Section 31 20 00 "Earthmoving".

3.4 SALVAGE MATERIALS:

A. Carefully remove items designated for Salvage, or "Remove and Relocate", to avoid damage. Store site items indicated for salvage, or "Remove and Relocate", to prevent damage during construction. Relocate items as indicated on site plan or as directed in the field by the Owner's Representative. Contractor shall replace salvage items damaged during removal, storage or relocation operations at no increase to the Contract sum.

3.5 WASTE MATERIAL DISPOSAL:

A. Transport demolition waste materials from the project site to legal offsite waste disposal areas. Document legal offsite waste disposal areas. Retain all waste disposal manifests for submittal to the Owner at the end of the project. Refer to Section 01 74 19 "Construction Waste Management and Disposal".

END OF SECTION

SECTION 31 20 00 - EARTHMOVING

PART 1 GENERAL:

1.1 RELATED DRAWINGS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections, apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials, equipment and work required to perform earthwork and grading operations for site development.

1.3 TESTING AND INSPECTIONS:

A. The Owner shall be responsible for providing a Maryland Registered Professional Soils Engineer for required testing and inspections.

B. Services of the Soils Engineer will not necessarily be on a full time basis, but will include the number of visits and tests required to observe the performance of all earthwork under this Section. If in the opinion of the Soils Engineer, any work performed under this Section does not meet the technical or design requirements stipulated for the work, the Contractor shall make all necessary readjustments to his approval.

C. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer's services are required. The Soils Engineer's duties will include, but not be limited to the following:
   1. Observation, testing, and approval of subgrade for footings before placement of concrete.
   2. Observation and approval of floor subgrade and fill placement before placement of underfloor granular base.
   3. Testing of proposed import fill material and verification of correlation of the import material to laboratory test samples. All test results shall be forwarded to the seeding and sodding contractor.
   4. Verification of removal of sediment from sediment control basins and testing of subgrade in basins prior to fill placement.

1.4 RELATED WORK:

A. Refer to Section 31 10 00 "Clearing".

B. Refer to Section 31 20 05 "Building Earthwork".

1.5 CODES:

A. Contractor shall comply with the applicable requirements of the governing agencies having jurisdiction.

1.6 DEFINITIONS:

A. Excavation: Removal of earth materials to subgrade elevations indicated or specified.

B. Over-Excavation: Removal of earth materials, beyond subgrade elevations indicated or specified, without written authorization from the Architect.

C. Unsuitable Earth: Soft or unstable earth materials beyond limits of excavation indicated (e.g. muck, soft clays, organic soils, peat, etc.).

D. Fill: Placement of earth materials over existing ground surfaces to subgrade elevations indicated or specified.

E. Backfill: Placement of earth materials in excavations to subgrade elevations indicated or specified.

F. Soils Engineer: Shall be a Licensed Professional Engineer, currently registered in the State of Maryland, or shall be an authorized representative of such an engineer.

G. Rock: Defined as material that cannot be dislodged by a Caterpillar Model No. D-8N, heavy duty track-type tractor, rated at not less than 285 hp flywheel power and equipped with a single shank hydraulic ripper, capable of exerting not less than 45,000 lbs breakout force. Rock excavation includes up to 6-inches over-excavation below the required excavation depth. This definition of rock does not include materials such as hardpan, loose rock, concrete or other materials that can be removed by means other than drilling and blasting, but which for reasons of economy in excavating the Contractor chooses to remove by drilling and blasting.

1.7 SUBMITTALS:

A. Density Test Results: The Contractor shall submit copies of the results of the specified density testing to the Owner's Representative for review and approval.

B. Submit location of product manufacture and of extraction/recovery of primary raw materials.

C. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.

D. For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.

E. For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.8 PROJECT CONDITIONS:

A. Existing Subsurface Conditions: All excavation materials shall be "unclassified".

B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.

1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

1.9 CONSTRUCTION SURVEYS:

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined vertical and horizontal stakes required to perform earthwork operations to subgrade elevations indicated or specified.

1.10 EARTHWORK BALANCE:

A. Perform all earthwork operations regardless of actual quantities encountered.

1. Excess materials shall be legally disposed of off project property.
2. Off-site borrow shall be provided at no increase to the Contract sum.

PART 2 PRODUCTS:

2.1 MATERIALS:

A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.

B. Fill Materials: Soils used as fill materials shall have Unified Soils Classification (ASTM D 2487) of ML or better, but shall exclude highly plastic clays or silts (MH-CH). Soil material for fill shall be free of organic matter or debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding three inches in any dimension. No more than 15 percent of rocks or lumps shall be larger than 2½ inches in any dimension. Materials shall be non-frost susceptible soils, have a maximum of 3% moisture content, shall have a liquid limit of less than 40, and a plasticity index of less than 12.

1. Fill material used within the top 12 inches of fill shall be free of rocks or stones exceeding one inch in any dimension.
2. Recycled concrete (RC-6) subbase may be used as fill material, except under building slab.
3. Standard Proctor Maximum dry density: 110 lbs per cubic feet (minimum)

C. Backfill Material: As indicated for fill material.

D. Borrow Material: Off-site borrow, if required, shall be as specified for Fill Materials. Obtain and transport borrow material at no increase to the Contract sum.

PART 3 EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. General: Provide protection to prevent settlement, movement, undermining of or erosion to existing site improvements, existing utilities, existing buildings, new site improvements, new buildings and new utilities.

B. Do not permit heavy equipment to pass over any utility until a minimum of two feet of compacted fill or backfill is placed over the top of utility.

C. Restore damage, at no increase to Contract sum, resulting from the lack of protection or improper installation of protective measures or careless execution of construction activities. Restoration work to be approved by the Soils Engineer and Owner's Representative.

3.2 EXISTING UTILITIES:

A. Notify all public utility companies, 48 hours prior to the start of earthwork operations. Verify and mark horizontal utility locations prior to the start of earthwork operation. Manually excavate and expose utilities as earthwork operations approach marked locations.

B. Immediately notify the Owner's Representative or the Architect in the event horizontal or vertical utility locations differ from locations indicated. Provide horizontal and vertical details of utility locations as directed by the Owner's Representative or the Architect. Conflicts with construction to be determined by the Owner's Representative or the Architect. Payment for correction of unforeseen conflicts with construction shall be by change order.

C. Coordinate public utility relocation work required for public utilities conflicting with construction. The Owner's Representative or the Architect will provide directions and details required to relocate utilities conflicting with construction.

D. Do not disconnect or interrupt existing utilities serving existing facilities to remain without notification and authorization of the Architect or the Owner's representatives.

3.3 DEWATERING:

A. Perform earthwork and grading operations to prevent surface or subsurface water from flowing into excavations, surface or subsurface water from flooding project site or adjacent property and water accumulations detrimental to stability of subgrades. Provide, install, operate and maintain all required pumps, sumps, discharge lines and related equipment.

3.4 EXCAVATION:

A. Excavate materials encountered to subgrade elevations indicated or specified. All excavation is unclassified. Excavate materials regardless of the character of the materials encountered, at no increase to contract sum.

B. Blasting – Blasting on this site is acceptable, provided it is performed in accordance with MDOT-SHA Standards and Specifications. Specifically section TC-6.07. In addition, the Contractor shall coordinate all blasting efforts with the Owner so as not to impact the User. Lastly, the Contractor shall be responsible for all impacts that blasting has on the adjacent buildings.

C. Subgrade Preparation: Upon completion of excavation activities, exposed subgrade shall be proofrolled utilizing a minimum 10-ton roller, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions. Any unsuitable materials discovered during proofrolling operations shall be removed and replaced as specified below. Upon completion of proofrolling activities and approval of the subgrade by the Soils Engineer, exposed subgrade shall be further prepared as follows:
   1. Unpaved Areas: Scarify subgrade to six-inch depth prior to topsoil placement.
   2. Paved Areas: Scarify subgrade to twelve-inch depth and compact to 98 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test

methods: ASTM D 698. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.

3.5 OVER-EXCAVATION:

A. Correct over-excavated areas as directed by the Soils Engineer. Remove unsuitable earth encountered as a direct result of over-excavation. Excavate and dispose of all unsuitable earth. Correct excavated area as directed.

3.6 UNSUITABLE EARTH:

A. Immediately notify the Owner's Representative or the Architect, and Soils Engineer in the event unsuitable earth is encountered during earthwork or subsequent construction operations. Stop all work within immediate area of unsuitable earth. Do not remove unsuitable earth until written authorization is obtained from the Owner's Representative and proper measurements are obtained. Excavate and dispose of all unsuitable earth upon receipt of written authorization from the Owner's Representative. Backfill excavated area as specified. Payment for unsuitable earth removal and associated backfill operations to be by change order.

3.7 EXCAVATED MATERIAL STORAGE:

A. Stockpile select excavated materials required for fill and/or backfill operations. Stockpile locations are shown on the drawings and the stockpiles are not to exceed the plan view areas shown on the drawings. All Stockpile locations are to be approved by the Construction Manager. Shape and grade stockpiles to prevent ponding of surface water. Temporarily stabilize stockpiles as specified on Soil Erosion and Sediment Control Drawings. Dispose of excess excavation materials as specified.
   1. Excess excavated material shall be legally disposed of by removal from the project site.

3.8 EARTH FILL:

A. Existing Ground Surface Preparation: Remove vegetation and topsoil as specified in Section 31 10 00 "Clearing". Proofroll exposed subgrade utilizing a heavily loaded dump truck or other pneumatic-tired vehicle of similar size and weight, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions.

B. Existing Subgrade Preparation: Remove unsuitable earth, upon completion of clearing and proofrolling operations, as specified. Continuously bench existing slopes exceeding four feet horizontal to one foot vertical. Bench sufficiently to accommodate earthmoving and compaction equipment. Select material, removed as a result of benching operations, may be used for fill and/or backfill as specified.
   1. Unpaved Areas: Scarify existing subgrade to six-inch depth and compact to 90 percent maximum dry density. Density test method: ASTM D 698.
   2. Paved Areas: Scarify existing subgrade to twelve-inch depth and compact to 98 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test method: ASTM D 698. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.

C. Fill Placement: Do not place fill material on frozen or muddy subgrades.
   1. Unpaved Areas: Place fill material in loose lifts not exceeding eight-inches.
   2. Paved Areas: Place fill material in loose lifts not exceeding eight-inches.

D. Fill Compaction and Moisture Control: Obtain compaction with approved compaction equipment. Provide compaction equipment of proper size and in proper mechanical operating

condition. All fill material shall be moisture conditioned to within two percent of optimum moisture content.

1. Unpaved Areas: Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 698.
2. Paved Areas: Compact each lift to 95 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test method: ASTM D 698.

E. Control moisture during placement and compaction operations. Remove and replace or scarify and aerate excessively moist material until required moisture content is obtained. Moisten excessively dry material by applying measured amounts of water uniformly to fill material until required moisture content is obtained.

3.9 EARTH BACKFILL:

A. General: Backfill excavations as promptly as work permits, but not until completion of inspection, testing and approval by the Soils Engineer.

B. Placement and Compaction: Do not place backfill on frozen or muddy subgrades.
1. Unpaved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 698.
2. Paved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density, compact the top 18" to 100% maximum dry density. Density test method: ASTM D 698.
3. All material to be moisture conditioned to within two percent of optimum moisture content.

3.10 GRADING:

A. General: Grade unpaved and paved areas to smooth and uniform surfaces and to prevent ponding of surface water.
1. Unpaved Areas: Areas to receive topsoil shall be graded to allow for installation of minimum 6 inches of topsoil. Refer to Section 32 93 05 "Topsoiling, Seeding and Sodding". Grade slopes exceeding four feet horizontal to one foot vertical, to smooth and uniformly rounded surfaces.
2. Paved Areas: Grade paved area subgrades to the lines, elevations and sections indicated or specified.

3.11 MAINTENANCE:

A. Maintain all paved access roads in a clean and dust free condition during earthwork or subsequent construction operations. Clean trucks and equipment, removing mud and debris, prior to entering project site access roads and public right-of-way.

B. Maintain completed areas of project site free of trash and debris. Scarify, regrade and recompact subgrades damaged or disturbed by adverse weather, soil erosion, settlement and subsequent construction operations.

3.12 TESTING:

A. The following tests will be conducted.
1. Laboratory Density Tests:
a. Test method: As specified.
b. Test interval: One test per each 15,000 s.f., or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per each 5,000 s.f., etc, for areas done by hand-operated machines.

2. 2. In-place Field Density Tests:
   a. Test method: ASTM D 1556-82 or D 2167.
   b. Density required: As specified.
   c. Test Interval: One test per 2,000 s.f., or fraction thereof, of compacted subgrade, or of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per 1000 s.f., etc, for each lift of fill or backfill compacted by hand-operated machines.

B. Correct work not conforming to specified densities as directed by the Soils Engineer, at no increase to the Contract Sum.

END OF SECTION

SECTION 31 20 05 - BUILDING EARTHWORK

PART 1 GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials, equipment and work required to perform building earthwork operations.

1.3 TESTING AND INSPECTIONS

A. Refer to Section 31 20 00 "Earthmoving".

B. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer's services are required. The Soils Engineer's duties will include, but not be limited to the following:
   1. Observation, testing, and approval of field density requirements.
   2. Observation, testing, and approval of subgrade for footings before placement of concrete.
   3. Observation and approval of floor subgrade and fill placement before placement of underfloor granular base.
   4. Testing of proposed import fill material and verification of correlation of the import material to laboratory test samples. All test results shall be forwarded to the seeding and sodding contractor.
   5. Verification of removal of sediment from sediment control basins and testing of subgrade in basins prior to fill placement.

1.4 RELATED WORK:

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving".

1.5 CODES:

A. Refer to Section 31 20 00 "Earthmoving".

1.6 STANDARDS:

A. Refer to Section 31 20 00 "Earthmoving".

1.7 SUBMITTALS:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Product Samples: Submit samples of the borrow material and structural fill material to the Owners' Testing Agency. Sample size to be fifty pounds. Number of samples to be determined by the Owners' Testing Agency. The Contractor is required to get signed transmittals

from the Owners' Testing Agency documenting delivery of samples to be submitted to the Construction Manager for Project Record.

C. For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.8 DEFINITIONS:

A. Refer to Section 31 20 00 "Earthmoving".

1.9 PROJECT CONDITIONS:

A. Refer to Section 31 20 00 "Earthmoving".

1.10 CONSTRUCTION SURVEYS:

A. General: Retain the services of a locally registered land surveyor or professional engineer to provide horizontal and vertical alignment stakes required to perform building earthwork operations to subgrade elevations indicated or specified, and horizontal and vertical alignment stakes required to construct footings and foundations.

B. Earthwork Balance Conditions: Refer to Section 31 20 00 "Earthmoving".

PART 2 PRODUCTS:

2.1 MATERIALS:

A. Provide aggregate manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

B. Fill Material: ASTM D 2487, Unified Soils Classification ML or more granular. Liquid limit not to exceed forty (40). Plasticity Index not to exceed twelve (12). Maximum particle size to be 2-1/2 inches. Free of debris, organic materials, waste materials and frozen materials. Obtain and transport fill materials from project site or borrow areas at no increase to contract sum.

C. Samples: Submit fill material samples for testing and approval to the Soils Engineer. Do not place fill until written approval is obtained. Sample approval will not relieve the contractor of the responsibility to have material placed conform to approved samples.

D. Porous Fill: ASTM C 33 Coarse Aggregate, size number 467 (1-1/2 inch to No. 4), blast furnace slag prohibited.
1. Size to be AASHTO M 43, size 57.

E. Backfill Material: Refer to Section 31 20 00 "Earthmoving".

PART 3 EXECUTION:

3.1 GENERAL:

A. Coordinate building earthwork activities with the application of termite treatment. Refer to Section 31 31 16 "Termite Control".

3.2 PROTECTION AND RESTORATION:

A. Refer to Section 31 20 00 "Earthmoving" and as noted. Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Protect footing, foundation and slab subgrades, with insulating materials, to prevent frost penetration. Restore subgrades damaged from the lack of protection. Restoration work as directed by the Soils Engineer.

3.3 DEWATERING:

A. Refer to Section 31 20 00 "Earthmoving" and as noted. Perform building earthwork operations to prevent water accumulations detrimental to stability of footing and foundation subgrades.

3.4 EXCAVATION:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Foundation Excavation: Excavate to footing and foundation elevations indicated or specified. Extend excavations horizontally beyond footings and foundations to permit formwork placement and removal, support system placement and removal, foundation drainage system installation, building utility installations, waterproofing and inspection. Do not place concrete until completion of inspections, testing and approval by the Soils Engineer. Trim and shape excavations by manual methods, prior to concrete placement.

C. Slab Excavation: Excavate to slab subgrade elevations indicated or specified. Excavate slab subgrades to smooth and even surfaces, free of voids and depressions. Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.

D. Below Slab Utility Excavation: Refer to Section 33 10 00 "Utility Standards" and as noted.
1. Trench width below and 12 inches above top of utility not to exceed 12-inch clearance on each side of utility.

3.5 OVER-EXCAVATION:

A. Refer to Section 31 20 00 "Earthmoving" except as noted. Correct over-excavated areas as directed by the Soils Engineer or Owner's Representative.

3.6 UNSUITABLE EARTH:

A. Refer to Section 31 20 00 "Earthmoving" except as noted. The Soils Engineer shall determine the least costly restoration method.
   1. Restore excavated areas by lowering footings and foundations to bottom of excavated area.
   2. Restore excavated area by backfilling with approved compacted fill material to design subgrade elevations.
   3. Payment for unsuitable earth removal and associated restoration operations will be by Change Order.

3.7 EXCAVATED MATERIAL STORAGE:

A. Refer to Section 31 20 00 "Earthmoving".

3.8 FILL:

A. Refer to Section 31 20 00 "Earthmoving", except as noted.

B. Earth Fill: Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Place fill material in loose lifts not exceeding eight inches and at moisture content within plus or minus two percentage points of optimum moisture content, and compact to 98 percent maximum dry density. Top 18 inches below foundations and slabs shall be compacted to 100 percent maximum dry density. Density test method: ASTM D 698.
   1. Compacted fill material shall extend at least ten feet beyond building lines for lateral support.
   2. Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.

C. Porous Fill: Upon approval of prepared subgrade, place porous fill in uniform lifts and compact to 70 percent relative density.

3.9 BACKFILL:

A. Refer to Section 31 20 00 "Earthmoving". Place and compact backfill as specified for fill, except as noted.

B. Backfill excavations as promptly as work permits, but not until completion of formwork removal, foundation drainage system installation, building utility installations, waterproofing, termite treatment, trash and debris removal, support system removal, temporary and/or permanent wall bracing installation, and inspection and approval by the Soils Engineer.

C. Exercise care in the placement of backfill material adjacent to structure. Place backfill evenly and in a manner to prevent wedging action against the structure. Place backfill uniformly around the structure in lifts of equal elevation. Correct damage from improper backfilling operations, as directed by the Soils Engineer or Owner's Representative, at no increase to the Contract Sum.

D. Backfill placement operations to be tested and approved by the Soils Engineer.

3.10 TESTING:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Foundation Subgrade Testing: For each stratum of soil, on which foundations will be placed, conduct one test to verify required design bearing capacities. Conduct a minimum of one test beneath each wall. Subsequent verification and approval of each foundation subgrade may be based on a visual comparison of each subgrade with related tested strata. Additional testing shall be conducted as required by the Soils Engineer.

3.11 MAINTENANCE:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Tests, inspections, and approvals specified will be conducted in accordance with applicable Division One Sections regarding "Testing Services".

END OF SECTION

SECTION 31 31 16 - TERMITE CONTROL

PART 1 GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.

1.2 RELATED WORK:

A. Refer to Section 31 20 00"Earthmoving", and Division 3 "Concrete".

1.3 DESCRIPTION OF WORK:

A. This section specifies application of Termite Control soil treatment prior to placement of concrete floor slabs, foundation walls or grade beams.

1.4 QUALITY ASSURANCE:

A. Applicator's Qualifications: Applicators shall be registered or licensed where required by State or City jurisdictions.

1.5 WARRANTY:

A. On final acceptance, furnish the Owner's Representative with a written guarantee, executed by the Applicator and the Contractor, stating application was made in accordance with this specification, and certifying that the applied soil termiticide treatment will prevent infestation of subterranean termites.

B. Guarantee effectiveness of treatment for not less than five years.

C. Guarantee to correct damage caused by termite infestations in treated areas, within the five-year guarantee period. If subterranean termite activity is discovered during the guarantee period, the Contractor will re-treat the soil and repair or replace damage caused by the termite infestation.

1.6 STANDARDS:

A. United States Department of Agriculture Federal Insecticide, Fungicide and Rodenticide Act.

B. The formulation of all soil poisons, insecticides, fungicides, etc. shall be registered under the Act and shall be registered with the appropriate agency of the State of Maryland.

1.7 SUBMITTALS:

A. Submit manufacturer's written mixing and application instructions.

B. Submit typewritten detailed description of termite treatment program to, and obtain approval from, the local jurisdiction prior to implementation.

C. Submit evidence of compliance with Federal and State regulations.

1.8 PROJECT CONDITIONS:

A. Protect occupied portions of existing structures to remain from fumes and vapors from application of the termite treatment.

PART 2 PRODUCTS:

2.1 SOIL TREATMENT SOLUTIONS:

A. General: Use an emulsible, concentrated termiticide that dilutes with water, specially formulated to prevent termite infestation. Fuel oil will not be permitted as a dilutent. Use only soil treatment solutions that are not harmful to plants.

B. Provide a solution consisting one of the following chemical elements:
Premise, Bayer.
1. Permathrin:
    a. Dragnet.
2. Cypermethrine:
    a. Prevail FT, FMC Corp.
    b. Dermon, ICI Americas, Inc.
3. Fenvalerate:
    a. Gold Coast Tribute, Du Pont
4. Isofenphose:
    a. Pryfon, Mobay Corp.

C. Mixes: Dilute with water to concentration level recommended by the manufacturer. Follow manufacturer's written mixing instructions.

PART 3 EXECUTION:

3.1 INSPECTION:

A. Verify that soil is in friable condition with moisture content low enough to permit absorption of toxicant solution. Remove any foreign matter which could decrease effectiveness of treatment.

B. Do not apply soil treatment until excavating, filling and grading operations are complete, except as otherwise required.

C. Do not apply soil treatment to frozen or excessively wet soils or during inclement weather.

3.2 APPLICATION:

A. Apply soil treatment to areas beneath concrete floor slabs on grade or fill, suspended slab structures, at hollow masonry foundations and grade beams and along interior and exterior sides of foundation walls and grade beams.

B. Apply soil treatment at expansion joints, control joints and all areas where slabs will be penetrated.

C. Do not apply soil treatment solution until excavating.

3.3 RATE OF APPLICATION:

A. Surface Preparation: Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake and level soil to be treated, except previously compacted areas under slabs and foundations. Toxicants may be applied before placement of compacted fill under slabs, if recommended by toxicant manufacturer.

B. Application Rates: Apply soil treatment solution as follows:

C. Under slab-on-grade structures, treat soil before concrete slabs are placed, using the following rates of application:
   1. Apply 4 gallons of chemical solution per 10 linear feet to soil in critical area under slab, including entire inside perimeter inside of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers.
   2. Apply one gallon of chemical solution per 10 square feet as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply one and one half gallons of chemical solution per 10 square feet to areas where fill is washed gravel or other coarse absorbent material.
   3. Apply 4 gallons of chemical solution per 10 linear feet of trench, for each foot of depth from grade to footing, along outside edge of building. Dig a trench six inches to eight inches along outside of foundation to a depth of not less than 12 inches. Punch holes to top of footing at not more than 12 inches on center and apply chemical solution. Mix chemical solution with the soil as it is being replaced in trench.

D. Under crawl-space and basement structures, treat soil along exterior and interior walls of foundations with shallow footings as specified above for exterior of slab-on-grade structures.

E. At hollow masonry foundations or grade beams, treat voids at rate of 2 gallons per 10 linear feet, poured directly into the hollow spaces.

F. At expansion joints, control joints, and areas where slabs will be penetrated, apply at a rate of 4 gallons per 10 linear feet of penetration.

G. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs when areas are covered by other construction.

H. Re-apply soil treatment solution to areas disturbed by subsequent excavation, landscape grading, or other construction activities following application.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL:

1.1 SUMMARY

A. Work of this section includes sheeting and shoring and bracing.

1.2 RELATED SECTIONS

A. Section 31 10 00: Clearing

B. Section 31 20 00: Earthmoving

1.3 SYSTEM DESCRIPTION DESIGN REQUIREMENTS

A. Shoring systems shall be designed to safely and adequately prevent collapse of adjacent materials and permit construction of Work to arrangement shown on Contract Documents.

B. Secure approvals, including those of local governmental agencies having jurisdiction.

C. Analyze site conditions. Make supplemental investigations as needed for proper design of shoring.

1.4 QUALITY ASSURANCE SUBMITTALS FOR DESIGN DATA

A. Prepare and submit design drawings and calculations showing analysis of work to be performed, including horizontal support for shoring.

B. Drawings shall include methods, equipment and work procedures.

1.5 QUALITY ASSURANCE

A. Qualifications
   1. Bracing and shoring drawings shall be prepared by a registered professional engineer, licensed to practice in the State of Maryland. Drawings and calculations shall bear seal of Professional Engineer registered in the State of Maryland.
   2. Personnel performing installation shall be trained or qualified in techniques and procedures of shoring installation with a minimum of three (3) years successful experience in such installation.
   3. Installation shall be performed under supervision of a Professional Engineer registered in the State of Maryland, experienced in this type of work.

B. Regulatory Requirements: Conform to requirements of Occupational Safety and Health Administration (OSHA) as well as measures accepted as standards of industry.

C. Certifications: Upon completion of shoring, submit a letter signed and sealed by design engineer stating that, to best of his or her knowledge, systems were constructed in compliance with design drawings and calculations.

1.6 LEED Submittals

A. Product data for Credit MR 4.: For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.

B. Product data for Credit MR 5: For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

PART 2 – PRODUCTS:

2.1 MATERIALS

A. Materials shall be selected and furnished to perform in compliance with design criteria.

B. Structural Steel Shapes and Plates: ASTM A 36 or ASTM A 572. Steel shall be of American manufacturer, new and free from defects in strength, durability, appearance and function.
   1. Recycled Content: Provide steel with minimum 90 percent total recycled content, including at least 60 percent post-consumer recycled content.
   2. Regional Materials: Provide steel manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

PART 3 – EXECUTION:

3.1 EXAMINATION

A. Site Verification of Conditions: Prior to commencing work of this Section, check and verify governing dimensions and elevations, including field measurements of existing or adjoining work on which this work is dependent to assure proper fit and clearances between new and existing structures.

3.2 PREPARATION

A. Protection
   1. Protect and support water, sewer, gas, and other pipes and electrical conduits encountered and immediately notify persons, companies or governmental agencies, granting them ample opportunity to take such additional precautions as they may deem necessary.
   2. Cut and cap street connections encountered in excavating along curb lines in compliance with local jurisdiction requirements. Mark locations of capped utilities so they may be subsequently located and reconnected as needed.
   3. Damage to adjacent properties, streets, sidewalks and utilities caused by work under this Section shall be repaired, restored to original condition, or replaced at no additional expense to Owner.

B. Coordination
   1. Prepare a photographic or video survey of existing crack conditions in adjacent facilities and other conditions of structures prior to commencing work.
   2. Maintain free flow of pedestrian and vehicular traffic to and from adjacent properties at levels existing prior to start of work and as described in Section 31 10 00 "Clearing".

3. Interior bracing shall be arranged to offer no interference with formwork for new construction.
4. Provide sufficient quantity of materials on hand at all times for protection of Work and for use in event of emergency.
5. Setting of formwork, reinforcing and placement of concrete shall be in compliance with requirements described in other related Sections of this Project Manual.
6. Provide pumps and other equipment as necessary to dewater excavations for shoring operations.

C. Sheeting
1. Provide sheeting of proper lengths and section needed, and anchor or brace to resist earth and hydrostatic pressures and superimposed loads from adjacent structures and/or construction equipment.
2. Install sheeting plumb and true, to lines and locations as indicated on design submittal drawings. Sheeting shall be used to form concrete walls and shall be located and driven to ensure that no part of sheeting is within outline of permanent construction.
3. Sheeting retaining earth on which support and stability of existing structures is dependent shall be left in place at completion of Work.

D. Shoring
1. Locate shoring at distances away from new construction sufficient to allow working room and observation of construction.
2. Shoring shall be set clear of permanent footings, walls and other structural features.
3. Shoring shall be installed to retain earth under surcharges, including such loads as weight of construction materials and equipment, vibration, snow, rainwater, water absorption by soils, and temporary construction.
4. Extend shoring as high as necessary to allow for construction of foundation walls and for berming to divert water run-off. Depth of shoring shall be as deep as necessary to brace excavation to ultimate depth.
5. Shoring supporting formwork may not be left in place upon written approval by the Owner's Representative.

3.3 RESTORATION

A. Remove temporary protective installations upon completion of shoring operations.

B. Repair damage to structures caused by shoring operations and restore surfaces to original or better condition.

3.4 CLEANING

A. Remove debris and excess earth resulting from shoring operations as it accumulates. Do not store debris on site or permit debris to be scattered over site.

END OF SECTION

SECTION 32 12 16 - HOT-MIXED ASPHALT PAVEMENT

PART 1 GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct new asphalt pavement, asphalt curbing, asphalt walks and overlay existing asphalt pavement.

1.3 RELATED WORK:

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving", and Section 32 13 15 "Concrete Curbing".

1.4 STANDARDS:

A. Maryland Department of Transportation State Highway Administration, current "Standard Specifications for Construction and Materials".

B. Frederick County Department of Transportation current "Design Standards".

1.5 SUBMITTALS:

A. Products:
   1. Submit asphalt plant mix formula, for each course specified. Mix formula to include percentage of aggregate passing each sieve size, percentage of bituminous material added to aggregate and mix temperature.
   2. Submit certificates, signed by producer or manufacturer and contractor, stating that base course material and asphalt comply with this specification.
   3. Submit results of testing specified for review by the Architect, Owner's Representative and required jurisdictional inspectors.
   4. For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
   5. For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.6 PRODUCT DELIVERY AND STORAGE:

A. Asphalt mixtures: Delivery temperature not to exceed 25 degrees Fahrenheit below plant mix temperature.

1.7 PROJECT CONDITIONS:

A. Existing Asphalt Pavements: Verify existing pavement conditions (e.g. deteriorated surface, joints, etc.) during prebid inspection.

B. Traffic: Maintain vehicular traffic during pavement construction operations.

C. Limitations: Do not proceed with pavement construction until underground utility construction is complete. Do not proceed with asphalt placement operations until adjacent or adjoining Portland cement concrete curb construction is complete. Do not place bituminous materials when ambient air temperature is below 40 degrees Fahrenheit or air temperature has been below 35 degrees Fahrenheit for 12 or more consecutive hours. Do not place materials from 15 November to 1 March without written authorization from the Architect.

D. Construction Surveys: Retain the services of a locally registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for road base construction.
   1. Paved area base alignment stake horizontal interval: 50 foot maximum stations at centerline and both edges to finished base elevations.

PART 2 PRODUCTS:

2.1 MATERIALS:

A. General: Provide products manufactured and of raw materials extracted/recovered within a 500-mile radius of the Project Site.

B. Subbase Course: SHA Graded Aggregate Subbase: Section 901.01.

C. Asphalt Base (Binder) Course: Shall be Bituminous Concrete intermediate band, SuperPave, 19.0mm PG 64-22 Band per Division 5000 and Section 904A of the Reference Specification. Compacted thickness as noted on the plans.

D. Tack Coat: SHA cut-back asphalt: Section 904.04, M 81 or M 82.

E. Overlay Binder Coat: Asphalt cement: AASHTO M 20, penetration grade 80-100.

F. Overlay Protective Membrane: "Petromat" protective membrane manufactured by Phillips Fiber Corporation, a subsidiary of Phillips Petroleum Company, Greenville, South Carolina.
   1. Option: "AmoPave" protective membrane manufactured by Amoco Fabrics Company, Atlanta, Georgia.

G. Overlay Protective Membrane Strips: "PavePrep" fiber reinforced mastic strips, manufactured by The PavePrep Corporation, Westfield, New Jersey.

H. Asphalt Surface Course: Shall be Bituminous Concrete surface band, SuperPave, 9.5mm PG 64-22 Band per Division 5000 and Section 904A of the Reference Specification. Compacted thickness as noted on the plans.

I. Asphalt Surface Course for Athletic Courts and Paved Play Areas: Shall be Bituminous Concrete surface band, SuperPave, 4.75mm PG 64-22 Band per Division 5000 and Section 904A of the Reference Specification. Compacted thickness as noted on the plans.

J. Joint Sealant: MDOT-SHA Section 911.01.

K. Provide minimum 25 percent recycled asphalt paving (RAP).

PART 3 EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Asphalt Pavement: Protect improvements and facilities during tack coat and overlay binder coat applications to prevent overspray damage. Protect completed surface from damage. Do not permit heavy equipment or rollers on completed surface. Do not permit vehicular traffic on surface for 24 hours after completion. Restore damaged pavement as directed by the Owner's Representative or the Architect, at no increase to contract sum.

3.2 SUBGRADE PREPARATION:

A. Paved Areas: Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Verify subgrade compaction and elevations and correct discrepancies before proceeding with base construction. Verify utility casting elevations and reset or adjust to meet flush with finished pavement surface. Do not place the base material/subbase material on frozen or muddy subgrade.

3.3 SUBBASE COURSE:

A. Place subbase course material on prepared subgrade in one uniform layer to depth required to produce compacted thickness indicated. Shape material, to sections and elevations indicated with blade grader and compact with pneumatic tired rollers to 98 percent maximum dry den-

sity. Control moisture content of the base course material to within 2 percent of optimum during compaction operations. Compaction Standard: ASTM D 698. Proof roll subbase course with 10 ton tandem steel wheel roller and correct irregularities.

3.4 ASPHALT BASE COURSE:

A. Subbase Course Surface Preparation: Apply tack coat material to previously placed asphalt base course, existing pavement, curbing, utility castings and any structure abutting or projecting into paved area.

B. Base Course Placement: Place asphalt in layers not exceeding four inches in compacted depth to total depth required to produce compacted thickness indicated. Place material with mechanical self-powered pavers capable of maintaining required line and grade. Place material by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225 degrees Fahrenheit at the time of placement.

C. Base Course Compaction: Compaction operations shall begin immediately following placement of the base course material, and shall consist of breakdown, intermediate and finish rolling. Material shall be compacted to in-place density of 92 to 97 percent of theoretical maximum density. In-place compaction shall be completed before the material cools below 185 degrees Fahrenheit. Use self-powered tandem steel wheel rollers. Use power driven trench rollers in areas inaccessible to self-powered equipment. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips one half-roller width. Do not terminate alternate roller trips at the same location. Continue finish rolling until 98 percent to 102 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

3.5 ASPHALT SURFACE COURSE AND OVERLAY:

A. General: Provide overlay protective membrane treatment where indicated. Provide overlay protective membrane strips over all long, running cracks or pavement joints except in areas where overlay protective membrane is already indicated.

B. Asphalt Base Course Surface Preparation: Remove loose material from surface before applying tack coat. Apply tack coat material uniformly to surface at a rate of 0.10 gallon per square yard. Allow tack coat to cure as long as required to properly set but not less than 12 hours.

C. Existing Asphalt Pavement Preparation: Clean and dry pavement, with compressed air, removing debris, dust, foreign materials and moisture.
   1. Obtain pavement preparation approval, from the Architect prior to overlay binder coat application. Apply overlay binder coat material uniformly to prepared asphalt surface. Apply at a rate of 0.25 gallon per square yard. For long running cracks or joints in exist-

ing pavement surface where overlay protective membrane strips will be used, apply overlay binder coat material to a width of approximately two feet so as to span existing cracks or joints. Adjust application rate, based on existing pavement relative porosity, at no increase to contract sum. Apply overlay binder coat material at 300 degrees Fahrenheit minimum to 350 degrees Fahrenheit maximum.

2. Lay down overlay protective membrane, on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Transverse joint overlap to be 12 inches, "shingled" in the direction of paving to prevent edge pick-up by the pavers. Longitudinal joint overlap to be six inches. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.
3. Lay down overlay protective membrane strips on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Unroll overlay protective membrane strips, aligned with pavement joints, and seat in tacky overlay binder coat material by brooming, so as to span existing pavement joints. Blot excess overlay binder coat materials on the edges of the membrane strips with sand blanket. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.
4. Apply tack coat material uniformly to prepared asphalt surface. Apply at rate of minimum of 0.05 gallons per square yard and a maximum of 0.15 gallons per square yard. Tack coat to cure as long as required to properly set, but not less than 12 hours.
5. Prepare existing asphalt pavement, as indicated and specified, at no increase to contract sum.

D. Surface Course and Overlay Placement: Place asphalt, in one uniform layer, to depth required to produce the compacted thickness indicated. Place with mechanical self-powered pavers capable of maintaining required line and grade. Place and spread asphalt by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225 degrees Fahrenheit at the time of placement.

E. Surface Course and Overlay Compaction: Compaction operations shall begin immediately following placement of the surface course material, and shall consist of joint, breakdown, intermediate and finish rolling. In-place compaction shall be completed before the material cools below 185 degrees Fahrenheit. Use power driven trench rollers in areas inaccessible to self-powered rollers. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips, one-half roller width. Do not terminate alternate trips at same point. Continue finish rolling until 98 percent to 102 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

3.6 JOINT SEALING:

A. Completely seal and fill joints along existing and new pavement and curbing interface with joint sealant.

3.7 TESTING:

A. General: Correct work not conforming to specified tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.

B. Thickness Tests: Conduct subbase, base and surface course thickness tests and provide test area restoration upon completion. Tolerance not less than one-half inch from compacted thickness indicated. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.

C. Smoothness Tests: Conduct surface course smoothness tests. Tolerance not to exceed one-eighth inch between any two surface contacts on 10-foot straightedge. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.

D. Laboratory Density Tests: Conduct subgrade, subbase and base course laboratory density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1557. Test interval to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.
   1. Provide test area restoration.

E. Field Density Tests: Conduct subgrade, subbase and base course in-place field density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1556 or D 2167. Test locations are random and to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.
   1. Provide test area restoration.

3.8 CLEANING:

A. Clean improvements and facilities damaged by tack coat overspray as directed by the Owner's Representative or the Architect.

END OF SECTION

SECTION 32 12 20 - ROAD AND PARKING ACCESSORIES

PART 1 GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to apply, install and construct miscellaneous road and parking accessories.

1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 15 "Concrete Curbing".

1.4 STANDARDS:

A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction Materials".

B. "Manual on uniform Traffic Control Devices for Streets and Highways" ANSI D6.1-1971.

1.5 SUBMITTALS:

A. Products:
   1. Submit manufacturer's specifications and application instructions for pavement marking paint.
   2. Submit manufacturer's descriptive literature for road and parking area signs.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver paint to project site in original unopened containers bearing manufacturer's label.

B. Store paint in tightly covered containers.

1.7 PROJECT CONDITIONS:

A. Maintain vehicular and pedestrian traffic during pavement marking operations. Do not apply paint when ambient air temperature is below 50 degrees Fahrenheit, relative humidity exceeds 85%, wind exceeds 20 miles per hour or pavement surface temperature is below 50 degrees Fahrenheit.

B. Contractor shall notify Fire Marshal within 48 hours of completion of curbing and pavement construction to schedule site inspection for purposes of designating locations of curb marking. Curbs at fire lanes shall be painted yellow, unless noted otherwise by the Fire Marshal.

C. Curbs and line stripes at handicapped parking spaces shall be painted yellow.

D. All other on-site striping shall be white.

PART 2 PRODUCTS:

2.1 MATERIALS:

A. Pavement Marking: AASHTO M 248, type I, non-reflective paint, colors as noted. Materials used in the Public Right-of-Way shall be Type B, Class I, Thermoplastic alkyd. Materials used in the Public Right-of-Way shall be approved by Prince George's County Department of Transportation, Traffic Engineering prior to installation. Colors shall be
   1. Standard Parking Spaces: White
   2. Bus Stacking Spaces: White
   3. Handicapped Parking Spaces Yellow
   4. Traffic Lanes: Yellow

B. Curb Marking: AASHTO M 248, type I, reflective yellow paint.

C. Road and Parking Area Signs:
   1. Handicapped Parking Area and Fire Lane Signs: In accordance with Prince George's County Department of Transportation standards, and the MUTCD.
   2. Stop Signs shall be 30" by 30" signs.

D. Traffic Control Signs:
   1. Traffic control signs in accordance with Prince George's County Department of Transportation's standards, the MUTCD, and as indicated.

E. Sign Posts: Galvanized steel channel with 5/16 by two inch steel nuts and bolts and galvanized steel washers.

PART 3 EXECUTION:

3.1 PAVEMENT MARKING:

A. Surface Preparation: Clean pavement surfaces, removing grease, oil, mud and foreign materials.

B. Preparation for New Pavement Markings: Layout markings to dimensions and line widths indicated and specified. Bituminous concrete pavement to cool and set five calendar days prior to paint application. Do not apply marking materials to wet or damp pavement surfaces. Do not apply marking materials until pavement marking removal paint has set and hardened. Surfaces to set an additional eight hours after appearing dry.

C. Application: Thermoplastic pavement marking materials shall be applied to the pavement at a minimum temperature of 400 degrees Fahrenheit. Apply paint to width and length of pavement marking lines indicated, and as noted. Apply paint with spray equipment and/or conventional traffic line striping equipment, and in accordance with paint manufacturer's recommendations, to produce markings parallel and with sharp line edges, uniform in cross section and with line widths as indicated or specified. Minimum application rate to be 100 feet per gallon.
   1. Layout and apply paint for universal handicapped space symbols in accordance with standard practice and as directed by the Architect or the Owner's Representative.

D. Protection and Restoration: Protect completed paint marking from damage. Do not permit vehicular or pedestrian traffic on completed marking until paint has set and hardened. Restore damaged paint marking as directed by the Architect.

3.2 CURB MARKING:

A. Locations:
   1. Fire Marshal will tour site after completion of curbing and pavement construction. During tour Fire Marshal will indicate locations where curb marking is to be applied. Contractor shall apply markings at no increase to contract sum.

B. Application: Allow concrete curbing to cure 14 calendar days prior to paint application. Clean curb surfaces removing grease, oil, mud and foreign material. Do not apply paint to wet or damp curb surfaces. Apply paint to face and top of curbing by manual brush methods or with spray equipment.

3.3 ROAD AND PARKING AREA SIGNS:

A. Sign Locations: Locations of various sign types shall be as indicated on Construction Drawings and as directed by the Owner and the Architect. Contractor shall provide and install indicated and selected signs at no increase to Contract Sum.

B. Post Installation: Excavate post footing to 12 inch diameter and 30 inch depth. Place and consolidate concrete in footing excavation. Install post and assembled sign in concrete plumb to 1/4 inch in 10 feet and 24 inch depth. Provide bracing to prevent movement. Slope concrete surface one inch with outside edges flush with finished grade and trowel to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing.

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1 GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct Portland cement concrete walks.

1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 15 "Concrete Curbing".

1.4 STANDARDS:

A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction and Materials".

B. Prince George'sCounty, Department of Transportation's current "Design Standards".

1.5 SUBMITTALS:

A. The contractor shall construct an eight linear feet of typical concrete walk in the presence of the Owner's Representative, with a control joint. No additional concrete walk may be constructed until sample is inspected and approved by the Owner's Representative.
B. For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
C. For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.6 PROJECT CONDITIONS:

A. Traffic: Maintain pedestrian traffic during walk construction operations.

B. Limitations:
   1. Underground Utilities: Do not proceed with concrete construction until underground utility construction is complete.
   2. Curbing: Do not proceed with concrete walk construction until adjacent or adjoining curb construction is complete.
   3. Environmental: Refer to Section 33 10 00 "Utility Standards".

PART 2 PRODUCTS:

2.1 MATERIALS:

A. Recycled Content:
   1. Provide recycled concrete (RC-6) subbase and fill material, except under building slab.
   2. Provide minimum 25 percent recycled content in Portland Cement replacement with Engineer's approval.
   3. Provide steel bars with minimum 90 percent recycled content with at least 60 percent postconsumer.

B. Provide aggregate and steel reinforcing bars manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

C. Gravel Base: ASTM C 33 coarse aggregate, size number 6 (1" to No. 4).
   1. Contractor's Option: MDOT-SHA Coarse Aggregate No. 57 Stone.

D. Concrete: Class "A" Portland cement concrete, Section 33 10 00 "Utility Standards".
   1. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05

E. Joint Materials: Expansion and Isolation Joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

F. Forms: Steel or wood for straight or tangent walks. Non-rented wood materials shall be FSC-certified sustainably harvested.

G. Curing Materials: Liquid Membrane in accordance with MDOT-SHA Standards and Specifications for Construction and Materials section 902.07.03.

H. Joint Caps: All Construction, Expansion and Isolation Joints shall be topped with Vinylex Removable Cap Strip (Vinylex Corporation, www.vinylexwaterstop.com), or approved equal, and sealed with a polyurethane sealant.
   1. Joints between curbing and concrete walks shall not require sealant.
   2. Remove joint cap prior to caulking joint.

I. Miscellaneous Products:
   1. Form Release Compound: Non-staining, zero-VOC, 100% biodegradable made from plant-based oils and approved by the Architect.
   2. Cement Mortar: Section 33 10 00 "Utility Standards".

PART 3 EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Concrete: Protect completed concrete from damage. Restore damaged concrete as directed by the Owner's Representative or the Architect.

3.2 SUBGRADE PREPARATION:

A. Paved Areas: Section 31 20 00 "Earthmoving" and as noted. Verify subgrade elevations and compaction and correct discrepancies before proceeding with construction. Verify utility

casting elevations and reset or adjust to meet flush with finished concrete surface. Remove loose material from subgrade prior to gravel base placement.

3.3 GRAVEL BASE PLACEMENT:

A. Place and compact gravel base on prepared subgrade to depth indicated. Remove debris from surface of gravel base prior to placement of concrete. Do not place gravel base material on frozen or muddy subgrade.

3.4 FORMS:

A. Clean and coat forms with form release compound, prior to use. Install forms to lines, grades and elevations indicated or as specified. Brace forms to prevent movement during concrete placement.

3.5 EXPANSION JOINTS:

A. Install expansion joints at maximum 25-foot intervals or as indicated. Install expansion joints, adjacent to curbing, opposite curbing joints and as indicated. Place expansion joints perpendicular to concrete surface and with top edge 1/4 inch below concrete surface.

3.6 ISOLATION JOINTS:

A. Install isolation joints where concrete abuts buildings, existing walk sections, utility structures and concrete curb. Place isolation joints with top edge 1/4 inch below concrete surface.

3.7 CONTRACTION JOINTS (SCORE LINES):

A. Provide contraction joints at five-foot intervals or as indicated. Form contraction joints with 3/4 inch jointing tool.

3.8 CONCRETE PLACEMENT:

A. Sample Approval: No concrete walks may be constructed until the sample section has been inspected and approved by the Owner's Representative.

B. General: Place concrete in forms in one uniform layer. Consolidate concrete by tamping, spading or vibrating to prevent honeycombing. Place and consolidate concrete carefully to prevent dislocation of joint materials.

3.9 FINISHING:

A. General: Draw a fine hair broom across concrete surface. Where longitudinal grade exceeds five percent, use a coarse texture finish by drawing a stiff bristle broom across concrete surface. Do not add water to finish. Do not wet broom to finish. After screeding and bull floating allow surface water to recede into concrete prior to any other work on the concrete surface.

B. After concrete has cured, and with permission of Owner's representative, remove joint cap and provide joint filler (color to match concrete) that spans the expansion joint to prevent surface water from entering joint.

3.10 CURING:

A. Apply curing compound in accordance with Manufacturers recommendations.

3.11 TESTING:

A. General: Correct work not conforming to tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.

B. Walk Horizontal Alignment Test: Tolerance not to exceed 1/2 inch between any two contacts on 10-foot straightedge, except along horizontal curves. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.

C. Walk Surface Smoothness Test: Tolerance not to exceed 3/8 inch between any two surface contacts on 10-foot straightedge. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.

END OF SECTION

SECTION 32 13 15 - CONCRETE CURBING

PART 1 GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 and Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct Portland cement concrete curbing.

1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 13 "Concrete Paving".

1.4 STANDARDS:

A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction and Materials".

B. Prince George's County, Department of Transportation's current "Design Standards".

1.5 SUBMITTALS:

A. Submit cut sheets for construction of curb in the public right-of-way to and obtain approval from the governing jurisdiction and the Architect prior to curb construction.

B. The contractor shall construct an eight linear feet of typical concrete curb-and-gutter in the presence of the Owner's Representative, with a control joint. No additional concrete curbing may be constructed until sample is inspected and approved by the Owner's Representative.

C. LEED Submittals
1. Product data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
2. Product data for Credit MR 5: For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.6 PROJECT CONDITIONS:

A. Traffic: Maintain vehicular and pedestrian traffic during curb construction operations.

B. Limitations:
1. Environmental: Refer to Section 33 10 00 "Utility Standards".

2. Underground Utilities: Refer to Section 32 13 13 "Concrete Paving".

1.7 CONSTRUCTION SURVEYS:

A. Retain the services of a locally registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for curb construction within public right of way. Horizontal stake interval 25 feet maximum.

B. Provide combined horizontal and vertical alignment stakes for project site curb construction. Horizontal stake interval 25 feet maximum.

PART 2 PRODUCTS:

2.1 MATERIALS:

A. Concrete: MDOT-SHA Mix No. 7

B. Joint Materials: Expansion and isolation joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

C. Forms: For straight or tangent curbing use steel or wood. For curved curbing use flexible spring steel or laminated wood.

D. Curing Material: Refer to Section 32 13 13 "Concrete Paving".

E. Stone Base: SHA GA-Subbase, as indicated.

F. LEED Submittals
1. Recycled Content: Provide minimum 25 percent recycled content in Portland cement replacement.
2. Regional Materials: Provide aggregate manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

PART 3 EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Refer to Section 32 13 13 "Concrete Paving".

3.2 SUBGRADE PREPARATION:

A. Refer to Section 32 13 13 "Concrete Paving".

3.3 FORMS:

A. Refer to Section 32 13 13 "Concrete Paving", and as noted.

B. Form curbing to standards indicated and specified.

3.4 EXPANSION JOINTS:

A. Refer to Section 32 13 13 "Concrete Paving" and as noted.

B. Install expansion joints at maximum 30-foot intervals or as indicated. Place expansion joints perpendicular to surface and curbing face. Place combination curb and gutter expansion joints, with top edge one-half inch below gutter surface.

3.5 ISOLATION JOINTS:

A. Refer to Section 32 13 13 "Concrete Paving".

3.6 CONTRACTION JOINTS:

A. Refer to Section 32 13 13 "Concrete Paving" and as noted.

B. Provide contraction joints, perpendicular to surface and face of curbing, at 10 foot intervals. Place contraction joints at all points where curved and tangent sections of curbing meet. Place contraction joints with removable form spreader places. Contractor's option: Score or saw joints to 1-1/4 inch depth.

3.7 CONCRETE PLACEMENT:

A. Refer to Section 32 13 13 "Concrete Paving".

3.8 FINISHING:

A. Strike off top surfaces of curbing to top of forms and to smooth and uniform texture. Strip curb face forms when concrete takes initial set. Trowel curb face to smooth and uniform texture. Finish top surfaces and curb face to fine texture by drawing a soft bristle brush longitudinally along curb. Finish edges of curbing with edging tool having a radius as indicated. Maintain forms, except curb face forms, in place 12 hours after concrete placement. Correct defects (e.g. holes, honeycomb areas, broken edges, etc.) upon removal of remaining forms, with cement mortar. Finish contraction joints with 1/4-inch radius edging tool. Finish curbing joints to clean and true edges. Maintain curbing surfaces moist during finishing operations.

B. Curing: Refer to Section 32 13 13 "Concrete Paving".

END OF SECTION

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 the General Conditions and other Division 1 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

B. This Section includes the following:

1. Materials and Work Required to Construct Chain Link Fence and Gates and Related Accessories.

C. Related Sections:

1. Section 31 20 00: Earthmoving

2. Section 32 13 13: Cement Concrete Paving

3. Section 32 12 16: Hot-Mixed Asphalt Paving

1.3 CODES

A. Existing Underground Utilities: Refer to Section 31 20 00 "Earthmoving".

1.4 STANDARDS

A. Installation shall be per chain link manufacturer's standards (CLFMI).

1.5 SUBMITTALS

A. Submit manufacturer's descriptive literature, specifications and installation instructions for chain link fence and gates.

1. Include location of product manufacture.

B. LEED Submittals: Product data for steel components indicating percentages of pre-consumer and post-consumer recycled content.

C. Submit samples of vinyl-coated fabric 12 by 24 inches.

D. Warranty

1. Submit typewritten vinyl coated fence warranty signed by manufacturer and contractor.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver chain link fencing to the project site in original unopened containers bearing manufacturer's label.

1.7 QUALITY ASSURANCE

A. Provide complete fencing (of each type) produced by a single manufacturer.

1.8 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Limitations: Do not proceed with fencing installation until underground utility, bituminous concrete pavement and concrete curb and gutter construction is complete.

1.9 WARRANTY

A. Warrant vinyl coated fencing for 10 years against peeling, cracking and corrosion.

1.10 CONSTRUCTION SURVEYS

A. Retain the services of a registered land surveyor or professional engineer to provide horizontal alignment stakes for fencing located adjacent to site property lines. Horizontal stake interval 50 feet maximum, and at all angle points along property line.

B. Provide horizontal alignment stakes for project site fencing. Horizontal stake interval 50 feet maximum and at all corner points.

PART 2 – PRODUCTS

2.1 CHAIN LINK FENCING

A. Acceptable Manufacturers, giving preference to products manufactured within a 500-mile radius of the Project Site:

1. Anchor Fencing

2. Sonco Fence

3. Long Fence

4. P&H Tube Division/Southwestern Pipe

5. Allied Tube and Conduit Corp.

6. Other pre-bid approved manufacturer(s) meeting the requirements of this Specification Section will be considered in accordance with Specification Section 01630: Substitutions and Product Options.

B. General: Posts, rails, braces and bracing assemblies shall be high tensile steel pipe, cold-rolled and electric resistance welded from steel conforming to ASTM A 569, and hot-dip galvanized to ASTM A 525 G-90 zinc weight both inside and outside the pipe.

C. Finish: The outsides shall receive a conversion coating and fusion bonded polyester powder coating equivalent to "Lifecoat LCX" by P & H Tube. Coating color shall be black.

1. All fencing except Multipurpose Court shall have bottom tension wire.

2. All fencing shall have continuous top rail.

D. Fabric: 9-gauge (0.148-inch) core size, finished steel wires, galvanized in accordance with ASTM A 641-71a. Finish shall be thermally bonded PVC over galvanized steel, Class 2B, in accordance with

ASTM F 668. Coating color shall be black. Fabric shall have 2-inch diamond mesh pattern with top and bottom selvages knuckled.

E. Multipurpose Court Fencing: Mesh size shall be 1-3/4 inches. All court fencing shall have top rail and bottom rail.

F. Posts, Rails and Braces:

1. Terminal Posts (Corner Posts): Up to 6 feet: 2.375 inch O.D.; over 6 feet: 2.875 inch O.D.

2. Line Posts: Up to 6 feet: 1.90 inch O.D.; over 6 feet: 2.375 inch O.D.

3. Gate Posts (Hinge Posts): Leaf widths up to 6 feet: 2.875 inch O.D.; leaf widths 6 feet to 13 feet: 4.00 inch O.D.

4. Top Rail and Bottom Rail: Manufacturer's longest lengths, with expansion couplings (approximately 6 inches long) for each joint. Provide means of attaching top rail securely to each corner, end, and pull post.

5. Terminal and Gate Post Bracing Assemblies: Manufacturer's standard adjustable brace at end posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for braces. Brace line posts with 0.375-inch diameter rod and adjustable tightener.

6. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross section of 3/16" x 3/4". Provide one stretcher bar at each end post and two for each corner and pull post, except where fabric is integrally woven into post.

G. Gates

1. Gate framing shall be 2-inch square aluminum tube with fabric installed inside the frame with "J" bolts.

2. Hinges shall be manufacturer's standards.

3. Latches shall be butterfly type.

4. Height shall match adjacent fencing fabric, leaf swings 180 degrees.

H. Bottom Tension Wire: 7-gauge, O.D. = 0.177-inch core size, with PVC coating.

I. Post Tops (Caps): Weathertight closure caps, dome type, at each post, with openings to permit passage of top rails.

J. Hardware and Accessories: Galvanized per ASTM A 152 with manufacturer's standard polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010") thick.

K. Electrical Grounds: Provide at least one (1) electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

2.2 CHAIN LINK FENCING HEIGHTS

A. Heights shall be as indicated or as specified:

2.3 PADLOCKS

A. Padlocks manufactured by Master Lock Company, Milwaukee, Wisconsin. Provide one "Steel Secret Service" lock and furnish Owner with two keys for each gate.

2.4 CONCRETE

A. Class "B" Portland cement concrete, Specification Section 33 10 00: Utility Standards.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Utilities: Verify utility locations prior to fencing excavation operation. Adjust horizontal fencing alignment to avoid utilities at no increase to contract sum.

3.2 GRADING

A. Grade fence lines to smooth and uniform surfaces, free of depressions and high spots exceeding four inches in ten feet.

3.3 CHAIN LINK FENCING

A. General: Install in accordance with manufacturer's installation instructions and as noted. Install corner posts at horizontal alignment changes exceeding 30 degrees. Install line posts at intervals not exceeding ten feet. Install gateposts on both sides of gate opening.

B. Post Installation

1. Excavate post footings to minimum 18-inch diameters and 39 inch depths or as otherwise indicated.

2. Place and consolidate concrete in footing excavations. Install posts in concrete plumb to 1/4 inch in 10 feet. Provide bracing to prevent movement. Embed line post in concrete to 18 inches, terminal and gate posts to 24 inches. Slope exposed concrete footing surface one inch with outside edge flush with ground surface. Trowel exposed concrete footing surface to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing, or performing subsequent fencing operations.

C. Terminal and Gate Post Bracing Assemblies, Truss Rods and Tighteners and Tension Wire and Post Tops: Install in accordance with manufacturer's installation instructions and as specified.

D. Fabric: Each span shall be attached independently at pull and corner posts. Ends of fabric rolls and other section to be spliced shall be joined by weaving a single strand of the fabric wire into ends of

the fabric to create a continuous pattern of mesh. Fabric shall be stretched taut and securely fastened to each post and rail. Fastenings at ends, gates, corners, and pull posts shall be with stretcher bars and metal bands.

3.4 MAINTENANCE

A. Refer to Section 31 20 00 "Earthmoving".

- 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 and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Modular block retaining wall system.

B. Related Sections include the following:
   1. Division 2, Section 31 20 00, "Earthmoving"

1.3 PERFORMANCE REQUIREMENTS

A. Employ a qualified Professional Engineer licensed in the State of Maryland to design all segmental block retaining walls in accordance with the wall manufacturer's specifications and based upon information, including, but not limited to, soil properties, bearing capacities, and existing and proposed construction provided in the project Geotechnical Engineering Report and shown on the Contract Drawings, plans, profiles, details and notes. Review and request clarification of any information provided prior to submittal of bid to ensure that all Work costs are included in the Contractor's bid.

B. Design and construct all segmental block retaining walls to be capable of resisting all soil, hydrostatic and other applied pressures. Provide all wall construction, wall materials, backfill materials, geo-grid and/or other soil reinforcement materials required to accomplish this at no additional cost to the Owner.

C. Design and construct all segmental block retaining walls to lines and grades indicated on the Contract Drawings and to other dimensions and depths required so as not to de-stabilize or be de-stabilized by, or undermine or be undermined by, adjacent construction.

D. Install segmental retaining walls without damaging existing buildings, pavements, and other adjacent site improvements.

E. Obtain building permit for segmental retaining walls from authorities having jurisdiction. Submit a copy of said permit to the Owner for record.

1.4 SUBMITTALS

A. Product Data: Include data for proposed materials, method of installation, and list of materials proposed for use.

1. Material description and installation instructions for each manufactured product specified including Segmental Retaining Wall Units (SRW) and Geosynthetic Reinforcement.
2. Name and address of the production facility where the proposed SRW units will be manufactured. All units to be manufactured at the same facility.
3. Notarized letter from the SRW manufacturer stating that the units supplied for this project are manufactured in complete compliance with Section 2.3 of this specification. The letter shall state that the SRW units shown in the attached test reports are representative samples of the plants normal mix design and regular production runs. Include location of product manufacture.

B. Shop Drawings, System Designs and Calculations: Prepared by or under the direct supervision of a qualified Professional Engineer licensed in the State of Maryland who is experienced in the design of the proposed segmental retaining wall system. Include drawings and comprehensive engineering analysis that shows the system's compliance with specified requirements. Engineering design calculations prepared in accordance with the NCMA Design Manual For Segmental Retaining Walls, most current edition. Analysis shall include: Internal, External, Global Stability, and Bearing Capacity Calculations. System designs, materials, calculations and shop drawing must be signed and sealed by the qualified professional engineer responsible for their preparation and must be submitted to, reviewed by, and bear the approval stamp of authorities having jurisdiction prior to their submittal for review and approval by the Architect, Engineer and/or the Owner.

C. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of concrete units required shall be submitted to the Architect and Owner for review and approval.

D. Samples for Verification: Full-size units of each type of concrete unit for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

E. Test Reports:
1. Independent laboratory reports indicating compressive strength, moisture absorption and freeze-thaw durability of the concrete retaining wall units from the proposed production facility. Only test performed within the past 12 months will be considered current and valid.
2. Independent test reports verifying the long-term design strength properties (creep, installation damage, and durability) and soil interaction properties of the geosynthetic reinforcement.
3. Independent test reports verifying the connection capacity between the geosynthetic reinforcement and the concrete retaining wall units.
4. For projects with walls in excess of 25' in height, a completed Highway Innovative Technology Evaluation Center (HITEC) report shall be required for the proposed system.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with

project names and addresses, names and addresses of Architects and Owners, and other information specified.

G. LEED Submittals
1. Product data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.
2. Product data for Credit MR 5: For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed segmental retaining wall installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance. The Retaining Wall Company must have successfully completed the Segmental Retaining Wall training and exam of the National Concrete and Masonry Association.

B. Source Limitations: Obtain each type of concrete unit from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

C. Engineering Responsibility: Contractor shall engage a qualified Professional Engineer who will be responsible for the preparation of designs and data for the segmental retaining walls including drawings and comprehensive engineering analysis that shows the system's compliance with specified requirements.

D. Professional Engineer Qualifications: A professional engineer, in good standing, who is legally qualified and currently licensed to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services for designing segmental retaining walls that are similar to those indicated for this Project in material, design, and extent.

E. Arrange for and obtain any required inspections and certifications by authorities having jurisdiction.

F. Provide as-built information as required by contract and by authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect materials during storage and construction from earth and other materials. Protect segmental retaining wall materials from damage. Do not incorporate damaged materials into the retaining wall structure.

PART 2 – PRODUCTS:

2.1 MANUFACTURERS

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, giving preference to products manufactured within a 500-mile radius of the Project Site:

1. Available Manufacturers:
    a. Versa-Lok Retaining Wall Systems
    b. Keystone Retaining Wall Systems, Inc.
    c. Anchor Wall Systems
    d. Tensar Earth Technologies, Inc.
    e. Rockwood Retaining Walls, Inc.
    f. Cornerstone Wall Solutions, Inc.

2.2 COLORS AND TEXTURES

A. Colors and Textures:

1. Modular Block Retaining Wall Units: As selected by Architect from manufacturer's full range.
2. Concrete Retaining Wall Caps: Match color of color-conditioned concrete retaining wall.

2.3 MODULAR CONCRETE RETAINING WALL SYSTEM:

A. Modular Concrete Retaining Wall System: Use wall system materials and construct in accordance with the wall engineer's design and wall manufacturer's specifications to meet all performance requirements set forth in this specification.

B. Concrete Units: Comply with ASTM C1372 and the following requirements:

1. Face Finish: Sculptured rock face in angular tri-planar configuration or as otherwise approved by the Owner.
2. Strength: Minimum 28-day compressive strength of 3000 psi.
3. Maximum Moisture Absorption: 8 percent.
4. Concrete Units: Provide concrete units, mini, and end units provided by the wall manufacturer for use with the selected wall system and as required to meet the performance requirements set forth in this specification.

C. Base Leveling Pad Material: Provide and install continuous footing or base material required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification. Do not exceed soil bearing limitations.

D. Unit Fill: Provide and install unit fill material required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification.

E. Backfill Material: Provide and install backfill material required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification. Where possible use site excavated soils. Do not use unsuitable soil for backfill. Comply with Section 31 20 00 "Earthmoving" for backfill requirements.

F. Soil and Wall Reinforcement/Stabilization: Provide and install all temporary and/or permanent soil and wall reinforcement and stabilization materials required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification. Such materials include, but are not limited to, high density polyethylene expanded sheet, polyester woven fiber materials, mechanical anchors, sheeting, shoring and bracing specifically fabricated for use as soil reinforcement.

G. Non-Corrosive Connectors: Provide all pins, clips, or bars to connect successive horizontal rows of concrete blocks, possessing a verifiable strength and durability consistent with the design calculations of the wall as a whole and as required by the wall manufacturer and wall engineer for use with the selected wall system to meet the performance requirements set forth in this specification.

H. Adhesive: Exterior grade adhesive as recommended by the retaining wall unit manufacturer.

2.4 CONCRETE RETAINING WALL CAPS

A. To be cast in place per the drawings.

2.5 RETAINING WALL GUARD RAILS

A. Guard Rail or Fence shall be placed directly into the cap of the retaining wall as indicated on the drawings. The engineer will be responsible for designing the wall to account for loading onto the guardrail or fence that will be mounted into the cap. Placing the guard rail or fence outside of the cap will not be accepted or approved.

PART 3 – EXECUTION:

3.1 PREPARATION

A. Place leveling materials upon approved foundation to a minimum thickness of 6 inches. Compact material to provide a level surface. Compaction shall be 95 percent of Standard Proctor for sand or gravel type materials. Prepare leveling pad to ensure complete contact of retaining wall unit with base.

3.2 SEGMENTAL RETAINING WALL INSTALLATION

A. Install segmental retaining walls according to modular concrete unit manufacturer's written instructions and the approved shop drawings. Use wall system materials and construct in accordance with the wall engineer's design and wall manufacturer's specifications to meet all performance requirements set forth in this specification.

B. Except as otherwise required or recommended by the wall manufacturer and the contractor's wall engineer for construction of the selected wall system to meet the performance requirements set forth in this specification, retaining wall construction will meet the following minimum specifications:
   1. Place first course of concrete wall units on base leveling pad. Check units for levelness and alignment. Ensure that units are in full contact with base.
   2. Place units side by side for full length of wall alignment. Install non-corrosive connectors and fill voids at units with unit fill material as required by manufacturer. Tamp fill.
   3. Sweep excess material from top of units and install next course. Ensure each course is complete unit filled and compacted prior to proceeding to next course.
   4. Install Soil and Wall Reinforcement/Stabilization system, backfill and continue to lay up wall according to modular concrete unit manufacturer's written instructions and the approved shop drawings. When using geogrid, lay geogrid soil reinforcement horizontally on compacted backfill and connect to concrete wall units as indicated on manufacturer's shop drawings. Pull geogrid taut and anchor before backfill is placed on it.

3.3 CONCRETE WALL CAP INSTALLATION:

A. Except as otherwise required or recommended by the wall manufacturer and the contractor's wall engineer for construction of the selected wall system to meet the performance requirements set forth in this specification, the installation of the precise wall cap will meet the following minimum specifications:
   1. Caps shall be formed in the field of concrete, and anchored to the top of the wall per the manufacturer's recommendations.
   2. Precast caps are not acceptable.

3.4 CONSTRUCTION TOLERANCES:

A. Except as otherwise required or recommended by the wall manufacturer and the contractor's wall engineer for construction of the selected wall system to meet the performance requirements set forth in this specification, the installation of the precise wall cap will comply with the following as-built construction tolerances:
   1. Vertical Alignment: Do not vary from plumb by more than 1-1/2 inches over any 10-ft distance.
   2. Wall Batter: Do not vary more than 1 degrees of design batter.
   3. Horizontal Alignment: Do not vary more than 1-1/2 inches over any 10-ft distance.
   4. Corners, Bends and Curves: Do not vary 1-ft to theoretical location.
   5. Maximum Horizontal Gap Between Erected Units: ½-inch.

3.6 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified independent testing and inspecting agency to provide quality assurance and testing services during construction. Quality testing shall include foundation soil inspection, soil and backfill testing, and observation of construction.
   1. Testing Frequency:
      a. One test for every 2 feet (vertical) of fill placed and compacted, for every 50 lineal feet of retaining wall.
      b. Vary compaction test locations to cover the entire area of the reinforced soil zone, including the area compacted by the hand-operated compaction equipment.

END OF SECTION

SECTION 32 90 00 - TREE CONSERVATION

PART 1 GENERAL:

1.1 DESCRIPTION:

A. This section specifies labor, materials, and equipment and services necessary for and reasonably incidental to preservation, protection and care of trees as shown on the Drawings, specified or directed.

1.2 QUALITY ASSURANCE:

A. Methods for tree preservation and protection shall conform to details shown on the Drawings and any pertinent nationally recognized standards.

B. The Contractor shall during pre-construction activities, construction activities and post-construction activities employ an ISA (International Society of Arboriculture) certified arborist with a minimum of two years experience in tree preservation. The Contractor shall submit documentation that arborist has the above qualifications.

C. The arborist shall be on-site at any time work is being performed in the vicinity of trees to supervise implementation of procedures for tree protection, to monitor tree health during construction operations and the installation of pipes, curbs, sidewalks, etc and to supervise any repair of damages after construction.

1.3 SUBMITTALS:

A. Provide written report by a certified arborist identifying root evaluations of the trees, which are in potential conflict with construction to determine the critical root zones.

B. Provide written report by a certified arborist indicating the best methods of construction, which will minimize the impact on the critical root zone. Obtain specifications from the arborist for individual tree protection and maintenance as required for the identified to be saved on the Drawings.

PART 2 PRODUCTS:

1.1 TREE PROTECTION DEVICE:

A. Fencing shall be tenax alpi. It shall be blaze orange plastic mesh at least forty-eight (48) inches in height, with grid openings not greater than three (3) inches in width.

1.2 SOIL AMENDMENTS:

A. Suitable organic matter shall be peat moss, composted manure, deactivated sewage sludge or similar material as approved by the arborist or engineer.

B. Special soil mixture is composed of one part suitable organic matter and 6 parts backfill. Backfill material shall be loose, fine, friable, even textured loam. The mixture shall not contain any rock fragments larger than four (4) inches in any direction, nor construction debris of any sort.

PART 3 EXECUTION:

1.1 PRECONSTRUCTION ACTIVITIES:

A. The limits of disturbance shall be located and flagged by the Contractor in the field prior to any stress reduction or construction activities. Limits of Disturbance shall be placed outside of critical root zones of trees to be preserved wherever possible.

B. As shown on the plans, trees which are to be preserved shall have their roots pruned. Root pruning trenches shall be located within one foot of limits of disturbance. Roots shall be cleanly cut to a depth of at least 24 inches using a vibratory plow (cable laying machine), tooth-chain trencher or other acceptable equipment. Fill trench as soon as possible with soil mixture herein described and pack to eliminate air pockets.

C. Fertilize trees in construction area at the rate of 3 pounds of nitrogen per 1000 square feet of root zone disturbed. Apply fertilizer to entire critical root zone out to root pruning trench. Fertilizer should be at least 50 percent (50%) slow release nitrogen and contain other essential elements and micronutrients.

D. Water critical root zone immediately after applying fertilizer to saturate the top 6 inches of soil.

E. A mulch 2-4 inches deep comprised of weed-free straw, woodchips, shredded bark or leaves shall be applied in the critical root zone adjacent to the pruning trench. Mulching shall not extend farther than 20 feet from the pruning trench.

F. Trees which are dead or dying or are in poor condition prior to the start of construction shall be flagged and recorded on the plan.

G. Blaze Orange Plastic Mesh Fence
   1. All tree Preservation Areas shall be surrounded by blaze orange plastic mesh fences.
   2. Boundaries of fencing shall be staked, flagged and approved prior to installation.
   3. All fencing shall be installed prior to construction activities.
   4. Fences shall be firmly anchored at a spacing no greater than eight (8) feet and constructed in a manner which precludes sagging.
   5. All fencing shall be maintained in a good condition and promptly repaired or restored as the situation warrants.

1.2 CONSTRUCTION PHASE

A. Any on-site decisions regarding conditions or activities which may be injurious to the health of certain specimen trees in the vicinity of the construction area shall be made in consultation with the specified arborist.

B. Excavated and backfill material shall not be placed or side cast within the critical root zones of trees to be preserved.

C. Construction equipment shall not be driven into or through protected trees, nor shall swinging cranes or backhoes be allowed in their canopies.

D. There shall be no stacking or storing supplies within the critical root zones of trees to be preserved.

E. Trees to be removed shall be taken out without damaging protected trees.

F. There shall be no burning in or close to protected trees.

G. Changing site grades which will cause drainage to flow into or to collect near protected trees shall be prohibited. All grading shall take place outside the critical root zone of the trees to be protected.

H. All equipment shall be kept outside the blaze orange fencing.

I. In the event of drought, the protected trees shall be monitored for signs of stress and watered as needed or as directed by the arborist.

J. The certified arborist shall also monitor trees to be preserved for any other conditions or activities not mentioned above which may be injurious to their health.

1.3 POST-CONSTRUCTION ACTIVITIES

A. Repair & Care of Tree Damages
   1. The ends of any additional roots damaged or cut during the construction phase of the project which have not already been pruned and dressed at the outset of the project shall be cut off smoothly. Then peat moss or other suitable organic matter shall be added to the backfill material at a ratio of 1 part organic matter to 6 parts backfill. Fill and pack around roots to avoid air spaces. Restore grades to preconstruction elevations.
   2. Damaged limbs and dead limbs shall be removed if a safety hazard or if injurious to the health of the tree. Tree crown reduction procedures may be employed to promote the health of a tree and shall be performed by a certified arborist.
   3. If a tree is wounded during construction, under direction of the arborist, wounds should be cleaned, torn bark cut, and if possible the wounds dressed in a shape like a vertical ellipse, to facilitate rapid healing. Pruning knife shall be sharp and clean.
   4. Unless directed otherwise by the arborist, any compacted soil within the critical root zone of the trees to be preserved shall be mechanically aerated to a depth of eight (8) inches. Aeration holes should be spaced one foot on center and should be positioned to avoid severing major roots.
   5. The arborist shall inspect and review the trees within one-year after completion of construction and determine if the trees can be safely fertilized. The arborist shall make the initial fertilizer application and provide written instructions and information to the owner on successive fertilizer applications. After completion of construction the arborist shall perform Class II pruning on all trees to remove any damaged, dead, interfering and objectionable limbs one half inch in diameter and larger. The arborist shall selectively thin the trees to properly shape the canopy, reduce wind resistance and the possibility of storm damage.

1.4 REMOVAL OF TEMPORARY STRUCTURES

A. Remove blaze orange fencing.

B. Re-seed or sod disturbed areas in accordance with the Contract Documents.

END OF SECTION

SECTION 32 92 00 - LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.
3. Lawn renovation.
4. Erosion-control material(s).

B. Related Sections:

1. Division 2 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 2 Section "Earthwork" for excavation, filling and backfilling, and rough grading.
3. Division 2 Section "Exterior Plants" for border edgings.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

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

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and 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.

1. Certification of each seed mixture for turfgrass sod, identifying source, including name and telephone number of supplier.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required initial maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory (eg. The Pennsylvania State University). One composite soil sample test shall be submitted for every 5000 square feet of lawn area. All composite soil samples submitted for analysis shall be taken from no less than ten ½-cup samples at random from each sampling area. Each sample shall be extracted from a 6" deep core. The ten samples shall be mixed together to form a composite sample, from which a pint sample shall be extracted, air-dried, and submitted for testing. Tests shall include 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 topsoil, including magnesium, phosphorus and potassium. Submit soil test results to the Contractor and the Landscape Architect for review and approval prior to commencing soil amendment and seeding operations.

1. Acceptable Soil Test Results:

pH range: Bluegrass 6.0 – 7.0, Fescues 5.5 – 7.0

Texture: Both top and subsoil should be a sandy loam soil with 50-80% medium and coarse sand (< 25% fine sand), 5-20% clay, 5-35% silt.

Organic matter: 5% +

Magnesium: Minimum 100 pounds per acre

Nitrogen: Minimum 30 pounds per acre

Phosphorus: Minimum 100 pounds per acre

Potassium: Minimum 85 pounds per acre

Soluble salts: not to exceed 900 ppm

D. Preinstallation Conference: Conduct conference at Project site**.**

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 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 substantial completion.

1. Spring Planting: March 15 to May 15.
2. Fall Planting: September 1 to October 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit. No seeding shall be done on frozen ground or when the temperature is 32 degrees Fahrenheit or lower, or when soils are saturated.

PART 2 - PRODUCTS

2.1 SEED

A. Permanent grass seed shall consist of a MD Interagency Certified Mix of 2-3 cultivars of Improved Turf Type Tall Fescues from the latest edition of the University of Maryland

Agronomy Mimeo (Maryland Recommended list). Mixture must have a 98% purity rating and 90% germination.

B. Certified permanent grass seed for slopes exceeding 3:1 shall consist of Maryland Highway Permanent Mixture. Mixture shall consist of 80% Certified Tall Fescue, 10% Certified Perennial Ryegrass, and 10% Certified Kentucky Bluegrass plus 20 pounds per acre of Interstate Lespedeza.

C. Certified temporary grass seed shall consist of Italian, Perennial Ryegrass, or Millet.

D. All seed varieties shall meet the following minimum specifications:

Minimum Purity: 98%
Minimum Germination: 90%
Maximum Other Crop*: 0.5%
Maximum Weed Seed**: 0.1%

Noxious Weeds*** None

* Must be free of rye grass, timothy, orchard grass, bent grass, Canada bluegrass, clover or any other contaminant which shall be unsightly and uncontrollable.
** Must be free of dock, cheat, chess, chickweed, crabgrass, plantain, and black magic.
*** Must be free of all Maryland prohibited and restricted noxious weeds.

2.2 TURFGRASS SOD

A. State Certified Turfgrass Sod: Labeled, Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Sod shall be of live, growing grass not less than three (3) years old, of which not less than 90% shall be improved Tall Fescue (Rebel II, Rebel Falcon, Olympic) and not more than 10% Kentucky Blue Grass (Victa, Nassau) at the time of installation. It shall have not less than ½ inch of soil firmly attached to the roots. It shall be cut in strips not less than twelve (12) inches nor more than eighteen (18) inches wide.

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 6.0 to 7.2, a minimum of 5 percent organic material content. Stones larger than 1 inch in the longest dimension are not permitted. Stones ranging from 0.5 to 1 inch shall not exceed 5% of the soil volume, and gravel ¼ to ½ inches shall not exceed 5% of the soil volume. Particles greater than 1 inch in the longest dimension are not allowed. This includes fragments of brick, concrete, wood, glass, metal, stone and plastic. The total volume less than 1 inch long should not be more than 5% of the soil volume. The soil should have no herbicides, heavy metals, biological toxins, or hydrocarbons that will impact plant growth or at levels exceeding the EPA's standards for soil contaminants.

1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil.

a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.4 INORGANIC SOIL AMENDMENTS

A. Ground Limestone: ASTM C 602, agricultural limestone containing a minimum of 50 percent total oxides (calcium oxide plus magnesium oxide) and as follows:
1. One hundred percent shall pass a No. 65 sieve.

B. Sulfur: Granular, biodegradable, 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: Finely ground, containing a minimum of 90 percent calcium sulfate.

G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

H. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6.0 to 7.2; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inchsieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

B. Peat: Finely divided or granular texture, with a pH range of 6.0 to 7.2, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.7 FERTILIZER

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

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.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; 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.

2.9 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.

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

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. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

A. Limit lawn 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.

1. Apply fertilizer directly to subgrade before loosening.

2. Spread planting soil mix to a depth of 4 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.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
3. Remove stones larger than 1 inchin any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. 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.

E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, restore areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Lawn Preparation" Article.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

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.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
3. Do not seed into plant bed areas.

B. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

C. Protect seeded areas with slopes exceeding 1:3 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acreto form a continuous blanket I inch thick in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment, or
2. Bond straw mulch by spraying with asphalt emulsion. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

E. Protect seeded areas from hot, dry weather or drying winds by applying above mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly, and roll surface smooth.

3.6 HYDROSEEDING

A. 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.

3.7 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 LAWN RENOVATION

A. Renovate existing lawn.

B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
2. Provide new topsoil as required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing lawn.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch, or sod as required for new lawns.

K. Water newly planted areas and keep moist until new lawn is established.

3.9 LAWN MAINTENANCE

A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn 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 lawn with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow lawn 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 grass to a height of minimum 3 inches.

D. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

3.10 SATISFACTORY LAWNS

A. Lawn installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Lawn: 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
2. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

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 lawn is established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 02920

SECTION 32 93 00 - EXTERIOR PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Trees.
2. Shrubs.
3. Ground cover.
4. Plants.
5. Tree stabilization.

B. Related Sections:

1. Division 2 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 2 Section "Earthwork" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
3. Division 2 Section "Lawns and Grasses" for lawn and meadow planting.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Exterior 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 exterior plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with 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 exterior plant required.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

G. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.

H. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

I. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

J. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

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

B. Qualification Data: For qualified landscape Installer.

C. 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.. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for exterior plants.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

H. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory (eg. The Pennsylvania State University), 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 topsoil, including total calcium, magnesium, phosphorus, and potassium. Each sample to be submitted for testing shall be extracted from a composite sample representing a minimum of five core samples for each soil area.

D. Each soil test shall examine the following chemical and physical attributes. Any soil that falls within the indicated range of results shall be considered provisionally acceptable. Soil that falls outside any of the indicated ranges may be amended, retested, and resubmitted for approval by the Owner. Once a soil is considered provisionally acceptable, its pH level should be examined for suitability with the plants that are to be grown on the site. Special attention should be paid to the pH tolerances of plants that require acidic soils for healthy growth.

pH Range: 6.0 – 7.2

Texture: Both top and subsoil should be a sandy loam soil with 50-80% medium and coarse sand (< 25% fine sand), 5-20% clay, 5-35% silt.

Organic Matter: 5 % +

Calcium: less than 175 units or 3,000 pounds per acre.

Magnesium: 26-50 units or 71-124 pounds per acre.

Phosphorus: 26-50 units or 62-102 pounds per acre

Potassium: 26-50 units or 85-160 pound per acre

Electrical conductivity: 600 ppm or .4 mmhos/cm (.4 dS)

E. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

1. Selection of trees purchased for the Project will be made by Architect, who will tag trees at their place of growth before they are prepared for transplanting.

F. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

G. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, 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 30 days in advance of delivery to site.

H. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

B. Do not prune trees and shrubs before delivery except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, 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 exterior plants during delivery. Do not drop exterior plants during delivery and handling.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in 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 exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: Immediately after danger of frost has passed, until June 15.
2. Fall Planting: August 15 until December 1.
3. Note: Different plant types require different planting times and conditions. A professional horticulturalist shall be consulted to determine the proper time, based on plant species and weather conditions, to move and install particular plant material to minimize stress on the plant.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.

C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Installer's standard form in which 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 lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Substantial Completion:

a. Trees and Shrubs: Two years.
b. Ground Cover and Plants: One year.

3. Include the following remedial actions as a minimum:

a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
b. Replace exterior 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 exterior plant will be required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for all plant material: 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 plantings are acceptably healthy and well established, but for not less than maintenance period below.

1. Maintenance Period: From the time Landscape Installation begins until all Landscape Installation is complete and Owner assumes control of the site.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs 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. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

E. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

F. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

1. Provide balled and burlapped trees.
2. Branching Height: One-half of tree height.

B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:

1. Stem Form: Multi-trunk clump**.**
2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

1. Shrub sizes indicated are sizes after pruning.
2. Provide balled and burlapped or container-grown shrubs.

2.4 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

B. Form and Size: Specimen quality as described.

1. Shearing Designation: Natural, never sheared.

2. Provide balled and burlapped or container-grown material.

2.5 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.6 PLANTS

A. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

2.7 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 6.0 to 7.2, a minimum of 5 percent organic material content. Stones larger than 1 inch in the longest dimension are not permitted. Stones ranging from 0.5 to 1 inch shall not exceed 5% of the soil volume, and gravel ¼ to ½ inches shall not exceed 5% of the soil volume. Particles greater than 1 inch in the longest dimension are not allowed. This includes fragments of brick, concrete, wood, glass, metal, stone and plastic. The total volume less than 1 inch long should not be more than 5% of the soil volume. The soil should have no herbicides, heavy metals, biological toxins, or hydrocarbons that will impact plant growth or at levels exceeding the EPA's standards for soil contaminants.

1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil.

    a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.8 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 7; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inchsieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Peat: Finely divided or granular texture, with a pH range of 6.0 to 7.2, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives (Pine Fines): Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials. Must contain a minimum of 75 percent sawdust-size and dust-size particles.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.9 FERTILIZER

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. For trees, shrubs, and groundcovers: Composition should be 10 percent nitrogen, 6 percent phosphorous, and 4 percent potassium, by weight.
2. For perennials: Fertilizer should be a complete fertilizer that is slow-released.

2.10 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood, applied to depth of 2-3".

2.11 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, 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 or turnbuckles.
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch in diameter.
4. Hose Chafing Guards: Reinforced rubber or plastic hose at least 1/2 inch in diameter, cut to lengths required to protect tree trunks from damage.
5. Guy Cables: 5-strand, 3/16-inch- diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
6. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Install secured biodegradeable erosion control netting on all slopes of 30 percent or greater.

D. If specified plant material is unavailable, Landscape Architect must approve substitutions BEFORE plants are brought to the site.

E. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before planting. Make minor adjustments as required.

3.3 PLANTING BED ESTABLISHMENT

A. Loosen subgrade of **entire** planting bed to a minimum depth of 6 inches Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening, except when compost is used.
2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix over entire bed.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

3. Spread planting soil mix over entire bed to a depth of 12 inches minimum but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

4. Total depth of loosened and prepared planting beds must be a minimum 12 inches.

B. Finish Grading: Grade planting beds 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, restore planting beds if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant 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. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. If drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Subsoil removed from excavations may be used as backfill if it is suitable.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball one-eighth the depth of the ball above finish grades.

1. Remove burlap and wire baskets from tops of root balls and partially 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.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

C. Set balled and potted and container-grown stock plumb and in center of pit or trench with top of root ball 2 inches above finish grades.

1. Carefully remove root ball from container without damaging root ball or plant.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

D. Organic Mulching: Apply 2-3-inchaverage thickness of organic mulch extending 12 inches beyond edge of planting pit or trench.

3.6 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

3.7 TREE STABILIZATION

A. Trunk Stabilization: Where indicated, provide trunk stabilization as follows:

1. Upright Staking and Tying: Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend dimension shown above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

B. Guying and Staking: Guy and stake trees exceeding 14 feet in height and more than 3 inches in caliper unless otherwise indicated. Securely attach no fewer than 3 guys to stakes 30 inches long, driven to grade.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants as indicated. Landscape Architect to approve layout before planting.

B. Dig holes large enough to allow spreading of roots and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated.

1. Organic Mulch: Apply 2- 3-inch average thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.10 PLANT MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

3.11 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.12 DISPOSAL

A. Disposal: 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 02930

SECTION 32 93 05 - TOPSOILING, SEEDING AND SODDING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 through Division 16 Specification Sections, apply to the Work of this Section.

1.2 RELATED WORK

A. Earthmoving: Section 31 20 00

B. Landscaping: Refer to Civil Drawings and Section 32 95 00.

C. Temporary Seeding for Erosion Control: Refer to Civil Drawings.

1.3 REFERENCE STANDARDS:

A. The MDOT-SHA Standards and Specifications Manual, current edition.

B. The MDE Erosion and Sediment Control Handbook.

1.4 AREAS TO BE SODDED

A. All areas with slopes greater than 4:1. All areas between the Building and the first line of walkway or roadway around the Building perimeter, unless indicated otherwise on the drawings.

B. All other areas shall be seeded.

1.5 QUALITY ASSURANCE

A. All sod shall be transplanted within 24 hours from the time it is harvested, unless stacked at the project site in a manner approved by the Owner's Representative. Stacked sod shall be kept moist and protected from exposure to wind and sun. Any sod permitted to dry out shall be rejected.

B. Plant only during periods of favorable weather when conditions are suitable. Do not place sod at any time temperature is below freezing. No frozen sod shall be used, and no seed or sod shall be placed on frozen, powder-dry or excessively wet soil.

C. Seeding: Do not proceed with seed application before or after dates specified without written authorization from the Owner's Representative or Architect.

D. Soil amendments and rate of application shall be determined by laboratory test on soil.
   1. Areas to be seeded or sodded shall have a soil pH range of 6.5 - 7.0. Contractor shall be responsible for ensuring correct soil pH.

2. Test pH level in at least five equidistant locations on the site. Review with the Owner's Representative or Architect who will determine whether the average soil pH value is within acceptable range. If existing soil pH is adequate, no soil amendments are required.
3. If average pH value is greater than 7.0, add a commercial grade sulfur at rate derived from lab test, over area to be seeded.
4. If average soil pH value is less than 6.5, then agricultural limestone shall be applied at rate derived from lab test.

1.6 SUBMITTALS

A. Submit statement of certification from local nursery from which sod shall be obtained.

B. Upon request, submit square yard of sod to project site for inspection by Architect and Owner's representative.

C. Submit certificates, signed by producer and contractor, stating that soil amendments, seed and sod comply with this specification. Certificates to include the following:
1. Limestone: Type, percentage of calcium magnesium carbonates or oxides, and gradation.
2. Fertilizer: Type and analysis.
3. Seed: Seed mixture percentages (variety and/or specie) germination percentage, weed seed percentage and seed test date.

D. Submit copy of laboratory test results and soil amendment recommendations for review by the Architect and the Owner's Representative.

E. Submit the name and qualifications of a Professional Lawn Care Firm to perform lawn maintenance during the maintenance period. The firm shall be one whose primary business is lawn care. The firm must be approved by the Owner prior to completion of sod installation.

F. Submit a proposed Lawn Maintenance Plan, detailing scheduled maintenance and compliance with the requirements of this specification. The plan shall include the name and location of the selected professional lawn care firm that will be performing the maintenance.

1.7 DELIVERY, STORAGE AND HANDLING

A. Seed: Deliver seed in original sealed, labeled and undamaged packaging.

B. Sod: Harvest, deliver, store and handle sod in compliance with the requirements of TPI's "Specifications for Turfgrass Sod Materials," and "Specifications for Turfgrass Sod Transplanting and Installation" contained in the "Guidelines Specifications to Turfgrass Sodding".

1.8 GUARANTEE, INSPECTION AND FINAL ACCEPTANCE

A. Guarantee that at end of ninety days after sodding, a healthy first class lawn shall exist.

B. Upon written request from Contractor, at least ten days before date of inspection, Owner or Architect will perform an inspection of seeded and sodded areas.

C. After inspection, list of deficiencies or omissions requiring correction will be proposed. Items shall be corrected and are subject to same guarantee and final inspection until found acceptable. Be responsible for continued maintenance of that portion of the lawn which, after ninety days, has not been accepted by Owner.

D. Not withstanding punch list items, Owner will certify in writing substantial completion of lawns and acceptance of work. Upon completion, reinspection of repairs or renewals necessary, Owner will assume responsibility for continued maintenance of lawn.

PART 2 PRODUCTS

2.1 TOPSOIL

A. Topsoil shall be a natural, friable, granular soil containing organic matter, uniform composition and texture, and free from clay subsoil, stones, week plant root, sticks, gravel, trash or harmful chemicals. Obtain topsoil from project site stockpiles established during clearing operations, and amend as necessary. Obtain additional topsoil required for landscape development from off-site sources and transport to the project site at no increase to contract sum. Obtain approval from Architect to supply topsoil from more than one site. Do not excavate or haul topsoil when wet or frozen. All topsoil shall meet Maryland Erosion and Sediment Control Handbook requirements.

2.2 SOIL AMENDMENTS

A. Limestone: Agricultural grade limestone ground to such fineness that at least 10% passes a 100-mesh sieve, 50% passing a 40-mesh sieve, and at least 90% passes a 20-mesh sieve.

B. Sulfur: Commercial grade sulfur of equal grade, and quality as specified for limestone.

C. Gypsum: Agricultural grade gypsum ground to such fineness that at least 10% passes a 100-mesh sieve, 50% passing a 40-mesh sieve, and at least 90% passes a 20-mesh sieve.

2.3 FERTILIZER

A. Fertilizer: Complete organic or inorganic fertilizer with percentages of nitrogen, phosphoric acid, potash, and trace elements determined by the soil test. Fertilizer shall be delivered to the site in original unopened containers that bear manufacturer's guaranteed statement of analysis. Rate of application shall be determined by the soil test.

2.4 MULCHES

A. Straw Mulch: Air-dried, clean, mildew and seed free salt hay.

B. Fiber Mulch: Biodegradable, dyed wood, cellulose fiber mulch; non-toxic, free of plant growth or germination inhibitors; maximum moisture content 15%; pH range 4.5 to 6.5

C. Tackifier: Non-asphatic, colloidal tackifier, recommended by biber-mulch manufacturer for slurry application; non-toxic and free of plant growth or germination inhibitors.

2.5 SOD

A. State certified, nursery grown in nearby area, well rooted, free from disease, defects, insect infestation, or any unhealthy or abnormal condition, and free of weeds.

B. Sod Composition:
   1. General Site: Tall Fescue (Drought Tolerant, Full Sun Mixture)
      a. Certified Tall Fescue Cultivars, a mixture of at least two different types - 95%
      b. Certified Kentucky Bluegrass - 5%
   2. Ballfield Areas: Bermuda Grass Mix
      a. Bermudagrass (Cynodon Dactylon), varieties Tufcote or Vamont, 100%.

C. Submit statement giving locations of property from which sod is to be obtained and submit square yard sample of sod to site if requested.

2.6 SEED:

A. Seed shall be "Maryland Certified Seed", labeled in accordance with the State Seed Law. All seed used shall have been tested within the six months immediately preceding the date of sowing. The quality of the seed used shall be shown on the bag tags to conform to the specified guidelines. Purity and germination specified are minimum percentages by weight.
   1. Weed seed not to exceed 0.50 percent for each mixture. Noxious weed, including Johnson grass, Canada Thistle, Quackgrass and Poison Ivy are prohibited.

B. Seed Mixture:

Type	% by Weight	Min. % Purity	Min. % Germination
Tall Fescue:	80	95	85
(Provide a mixture of at least 3 separate types, "Rebel", "Gazelle", "Falcon", "Finelawn" or "Jaguar")			
Kentucky Bluegrass Improved	10	95	85
Perennial Ryegrass	10	95	85

   1. Substitutions of seed type or percentages will be allowed only upon approval of the Owner's Representative.

PART 3 EXECUTION:

3.1 FINISH GRADE

A. After rough grading has been completed and site cleared of construction debris, cover areas disturbed by construction or rough grade with minimum four inches of topsoil over earth to provide finish grade.

B. Final grades are indicated. Do not allow soil to pond. Firm topsoil by rolling to prevent washing and sinking. Degree of finish shall be that ordinarily obtained with blade grader or scraper. Finish surface to within 0.10 foot above or below established grade elevations indicated.

3.2 APPLICATION OF SOIL AMENDMENTS

A. If soil amendments are required, apply at rates specified. Bond topsoil mix to subgrade and mix soil amendments uniformly into topsoil by tilling, disking or harrowing to five inch depth. Adjacent to existing trees, adjust depth to avoid disturbances of tree roots.

3.3 FERTILIZING:

A. Incorporate fertilizer with soil in same manner as lime, and apply and incorporate with soil simultaneous with liming operations. Type of fertilizer and rate of application shall be as specified.

3.4 SODDING

A. Sod shall be laid smooth, edge to edge, with staggered joints and immediately pressed firmly into contact with sod bed by rolling to eliminate air pockets. True and even surface shall be provided to ensure knitting without displacement of sod or deformation of surfaces of sodded areas. In ditches or swales, sod shall be placed with longer dimension perpendicular to flow of water in ditch.

B. Following compaction, screened topsoil of good quality shall be used to fill cracks, and excess soil worked into grass with rakes or other suitable equipment. Grass shall not be smothered with excess fill soil. Exposed edges of sod shall be buried flush with adjacent soil.

3.5 SEEDING

A. Slurry Preparation: Slurry mixture for 1000 gallon tank:
   1. Seed Mixture: Set for minimum application rate of 350 pounds per acre or 75 pounds per tankful for lawns, 450 pounds per acre or 95 pounds per tankful for athletic field turf.
   2. Fertilizer: 182 pounds.
   3. Fiber Mulch: 310 pounds.
   4. Binder Additive: 20 gallons.
   5. Water: Fill tank.

B. Proportionally adjust mixture quantities for tanks of different capacities.

C. Slurry Application: Hydraulic application rate shall be 110 gallons per 1000 square feet. Application dates shall be 15 March to 15 May and 15 August to 31 October. Apply slurry mixture uniformly to prepared topsoil, in one continuous hydraulic operation. Do not begin hydraulic application until completion of topsoil preparation.

3.6 MAINTENANCE

A. Ensure the establishment of a healthy, first class lawn. Be responsible for all maintenance, protection, and repair until Owner accepts planted area. Include watering, rolling, fertilizing and mowing.

B. Maintenance shall be performed by a professional lawn care firm, whose primary business is lawn care. The Contractor shall submit the name of the lawn care firm to the Owner for approval.

C. Maintenance and protection of seeded and sodded areas shall continue until Owner accepts lawn. Barriers, sign, and/or flags shall be used on established pedestrian circulation ways as determined by Owner to indicate areas where trespassing is not allowed.

D. During the maintenance period repair or re-work washouts, dry areas, dead areas or erosion.

END OF SECTION

SECTION 32 95 00 – TREES, SHRUBS AND GROUND COVERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 through Division 16 Specification Sections, apply to the Work of this Section.

1.2 RELATED WORK

A. Earthmoving: Section 31 20 00

B. Topsoiling, Seeding and Sodding: Refer to Civil Drawings and Section 32 93 05.

1.3 REFERENCE STANDARDS:

A. The MDOT-SHA Standards and Specifications Manual, current edition.

B. The MDE Erosion and Sediment Control Handbook, current edition.

1.4 JOB CONDITIONS:

A. Prior to beginning work, the Contractor is required to schedule and attend an on-site meeting with the Owner, Architect, in order to verify site conditions and scope of work.

B. Proceed with and complete landscape work as rapidly as portions of site become available, working in cooperation with the construction manager and within seasonal limitations for each kind of landscape work required.

C. Utilities: Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is authorized.

D. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify architect or Owner's Representative before planting.

E. Coordination with Lawns: Refer to Section 32 93 05. Plant trees and shrubs after final grades are established and prior to seeding and sodding. If planting of trees and shrubs occurs after seeding and sodding, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

F. Extent of landscape development work is shown on drawings and in schedules, and specified herein.

G. The work shall include, but not necessarily be limited to the following:
   1. Disposal of unused excavated material from planting excavations only.

2. Furnishing, protecting and planting all trees and shrubs of types and sizes specified.

3. Pruning, trimming, feeding, and mulching trees where trees are marked to be saved.
4. Mulching new planting stock.
5. Wrapping and staking new planting stock.
6. Watering new planting stock.
7. Furnishing and installing portable drip irrigation bags at each new tree.
8. Providing mulched areas for pedestrian walkways.
9. Providing timber edging along disturbed play areas and pedestrian walkways

H. Subgrade elevations: Excavation, filling and grading required to establish elevations shown on drawings are specified elsewhere. Refer to Earthmoving, Section 31 20 00.

1.5 QUALITY ASSURANCE

A. Subcontract landscape work to a single firm specializing in landscape work and with a record of satisfactory performance on similar projects.

B. Quality Control:
1. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.
2. All plants shall be nursery grown under climatic conditions similar to those in locality of the project for a minimum of 2 years.
3. Stock furnished shall be at least the minimum size indicated. Provide plants indicated with a measurement range so that only a maximum of 50 percent are of the minimum size indicated and 50 percent are of the maximum size indicated.
4. Plants will be inspected and approved at the place of installation, for compliance with specification requirements for quality, size and type of specimen.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver materials in original packaging showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and storage on site.

B. Trees and Shrubs: Provide freshly dug trees and shrubs. Do not prune prior to delivery. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Provide protective covering during delivery.

C. Deliver trees and shrubs after preparation for planting have been completed, and plant immediately. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather extremes and mechanical damage, and keep rootball moist.

1.7 SPECIAL PROJECT WARRANTY

A. It shall be the Contractor's responsibility to water, fertilize and otherwise maintain plant materials in healthy condition, free of stress and insect infestation, until such time as the landscaping is formally accepted in writing by the Owner. The two-year warranty shall not commence until such formal notice is given by the Inspector.

B. Warranty new trees and shrubs for a period of two years after date of Inspector's acceptance, against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Installer's control.

C. Remove and replace unsatisfactory trees or plants or those found to be dead or in unhealthy condition during warranty period. Make replacements during growth season following end of warranty period. Replace in kind and size specified and plant in accordance with this Section.

1.8 SUBMITTALS

A. Submit the name and qualifications of a Professional Landscape Firm to perform Landscape installations and plant maintenance during the maintenance period. The firm must be approved by the Owner prior to beginning landscape work.

B. Submit a proposed Planting Maintenance Plan, detailing scheduled maintenance and compliance with the requirements of this specification. The plan shall include the name and location of the selected professional Landscape firm that will be performing the maintenance.

C. Maintenance Instructions: Submit typewritten instructions to be used by Owner for maintenance of landscape work for one full year after termination of maintenance period. Submit prior to expiration of required maintenance period(s).

D. Submit manufacturer's catalog information and installation instructions for flexible plastic landscape edging and mulch for pedestrian walkways.

E. Submit manufacturer's catalog information and installation instructions for portable drip irrigation bags for new trees.

F. For products having regional material content, documentation indicating location of harvest of plants. Include statement indicating cost of each product with regional material content.

PART 2 MATERIALS

2.01 TOPSOIL

A. Topsoil stockpiled for re-use shall be used in areas receiving seed or sod. Topsoil for planting shall be supplied from off-site sources by this Contractor.

B. Provide new topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2" in any dimension, and other extraneous or toxic matter harmful to plant growth. Determine pH of topsoil and add amendments as required.

C. Commercial Fertilizer: Complete fertilizer with some elements derived from organic sources and containing percentages of available plant nutrients recommended for each type of planting and of proper pH for each type of specimen (refer to Section 32 93 05).

2.02 PLANT MATERIALS

A. Plant materials shall be classified as per "American Standard for Nursery Stock", as adopted by the American Association of Nurserymen. Plant materials not meeting this standard shall be rejected.
   1. Conform to requirements of the plant list.
   2. All plant materials shall be nursery growth stock.
   3. Trees shall be well branched, with full crown.
   4. Each plant shall be free from disease, insect infestation, and dead branches.
   5. Each plant shall be balled and burlapped (B&B), with rootball fully intact.
   6. Substitutions may be made only after submission of evidence substantiating to the Architect's and Owner's satisfaction, non-availability of specified plant items and only if approved by the Architect.
   7. Substitutions may be made only with Architect or Owner's approval, at same price as unavailable contract item or at lower, approved price with a credit provided.

B. Planting Soil Mix: 3 parts by volume topsoil, 1 part by volume peat moss.

C. Mulch: Shredded hardwood or pine bark.

D. Deciduous Tree Wrapping: Approved tree wrapping paper 4 inch width.

E. Stakes, guy wire and tubing: Of kind and size per drawings for proper support of specimen.

2.03 MULCH FOR PEDESTRIAN WALKWAYS

A. Provide treated wood mulch over the entire area indicated on the drawings, to a minimum depth of 6".
   1. Acceptable ground covers: "Surflex", "Fibar", "Wood Carpet".

2.04 TIMBER EDGING

A. Timber shall be pressure treated for ground contact (0.40 #2 or better); recycled and/or creosoted timber shall not be acceptable.
   1. All edges shall be 1/2" radius.
   2. All lumber shall be free from splinters.
   3. Two tiers of lumber shall be provided with rowlock or half-lapped joints. Bottom tier of lumber shall be set into the ground, and staked to the ground with steel rods reinforcing bars, 1/2" round, 36" on center, and 24" deep.
   4. Top and bottom tiers shall be spiked together using galvanized fasteners.

2.05 FLEXIBLE PLASTIC EDGING

A. Edging shall be flexible high density polyethylene plastic, such as "Black Diamond Landscape Edging", by Valley View Industries, 1-800-323-9369.

2.06 PORTABLE DRIP IRRIGATION BAGS

A. Portable drip irrigation bags shall be UV treated polyethylene bags, reinforced with nylon webbing, with nominal capacity of 20 gallons. Bags shall be designed to be connected together to form larger units for larger trees, if needed. Bags shall be designed to be easily filled with a standard garden hose, and to release water into the root ball of the tree over sufficient time to prevent runoff. Drip irrigation bags shall be "Treegator" bags, as manufactured by Spectrum Products, Inc., Raleigh, North Carolina, 1-866-treegator (web page treegator.com).

2.07 Provide plants harvested within 500 mile radius of Project Site.

PART 3 EXECUTION:

3.01 GENERAL

A. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure Architect's and Owner's acceptance before start of planting work. Make minor adjustments as may be requested.

B. Preparation for Planting:
1. Planting hole: Prepare in accordance with drawings and dispose of soil removed from hole.
2. Tree planting: Plants shall be set plumb, planted at same depth that plants grew in nursery.
3. After placing plant in hole, planting soil mix shall be gently but firmly tamped and sufficiently watered to ensure soil contact around all roots.
4. Earth saucers or water basins shall be at least four (4) inches deep with diameter equal to that of plant ball.
5. Water plants thoroughly during and immediately after planting.
6. Mulch to cover saucer area of individual plants.
7. Wrapping shall cover entire trunk to height of first branch.
8. Guy with stake locations and depth per drawings, with a minimum of three stakes per tree.
9. Prune shortly after planting only when deemed necessary by Architect or Owner's Representative to remove broken and bruised branches.
10. Provide and install portable drip irrigation bags at each new tree. Provide single unit bags (20 gallons) for trees with 1" to 4" trunks, and combine bags to form a 50 gallon set for trees with 4" to 8" trunks. Install in accordance with manufacturer's instructions. Fill the bags and begin scheduled maintenance.

3.02 MULCH WALKWAYS

A. Prior to installing mulch, treat the existing surface to be covered with a contact herbicide such as "Roundup" to kill all existing vegetation under the mulch. Then apply a pre-emergent herbicide to the area to be mulched.

B. Cover the area to be mulched with a layer of filter cloth prior to installing mulch cover. Key the edges of the filter cloth layer a minimum of 6 inches down into the soil with the plastic edging, or pin the edges under the timber edging for timber edged walkways.

C. Cover the area to be mulched with a minimum tamped thickness of six inches of treated wood mulch.

3.03 EDGING

A. Install flexible plastic landscape edging in accordance with manufacturer's instructions. Leave enough edging exposed above grade to contain mulch. Install flexible plastic edging and timber edging where indicated on the Drawings.

3.04 CLEANUP AND PROTECTION

A. During landscape work, keep adjacent paved areas clean, and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

3.05 MAINTENANCE:

A. Contractor shall maintain all plants in a healthy condition. Contractor's maintenance responsibilities shall consist of pruning, watering, fertilizing, cultivating, weeding, mulching, tightening and repairing of staking, setting plants to proper grades or upright position, restoration of the planting saucer, and furnishing and applying sprays or other items as are necessary to keep the planting free of insects and disease and in thriving condition. Maintenance shall be performed by a professional Landscaping firm, whose primary business is landscaping and plant care.

B. Maintenance shall begin immediately after each plant is planted and shall continue for a period of 60 days from the date of acceptance by the Owner.

3.06 INSPECTION AND ACCEPTANCE

A. When landscape work described in this section is completed, the Architect and Owner's Representative will make an inspection to determine acceptability.

B. Where inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Architect and Owner's representative and found to be acceptable. Remove rejected plants and materials from project site, and replace with healthy specimens.

C. It shall be the Contractor's responsibility to diligently pursue approval of the landscaping from Frederick County, and to correct punch list inspection items, prior to Owners occupancy of the new construction.

END OF SECTION

SECTION 33 10 00 - UTILITY STANDARDS

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials, work and standards for site and utility construction materials and work.

1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving"; Section 33 41 00 "Storm Drainage", Division 22 "Plumbing" and Division 26 "Electrical".

1.4 STANDARDS:

A. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications".

B. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials", Measurement and Payment Clauses do not apply.

C. American Concrete Institute (ACI).

1.5 SUBMITTALS:

A. Products:
1. Submit typewritten list of selected products, when options are specified, within ten (10) calendar days after contract execution. Submit detailed shop drawings of utility modifications required by selection of options.
2. Submit manufacturer's descriptive literature of structure castings.
3. Submit Portland cement concrete mix design formula for each class specified.
4. Submit certificates, signed by manufacturer or producer and contractor, stating the following comply with this specification:
   a. Portland cement.
   b. Fine aggregates.
   c. Coarse aggregates.
   d. Portland cement concrete.
   e. Concrete masonry units.
   f. Brick.
   g. Foundation materials.
   h. Bedding materials.
5. Submit shop drawings, of the following, indicating concrete reinforcement locations, size and placement:

a. Cast in place reinforced concrete structures.
b. Pre-cast reinforced concrete structures.

6. Submit location of product manufacture and of extraction/recovery of primary raw materials.
7. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.
8. Submit certification of FSC-certified sustainably harvested wood formwork materials, if applicable.

B. Compaction Equipment: Submit compaction equipment data prior to start of controlled fill earthwork operations.

C. Testing: Submit test reports of testing specified.

D. "As-Built" Plans: Submit "as-built" plans for water, sanitary sewer, stormwater management, and storm drainage systems. Submit to the Owner's Representative and to controlling utility agencies as required.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Delivery: Schedule delivery operations to avoid unnecessary re-handling.

B. Storage:
1. General: Store in accordance with manufacturer's recommendations and as noted.
2. Portland cement: Store on platforms above ground and protect from adverse environmental conditions.
3. Aggregates: Store to prevent foreign material contamination.
4. Utility Joint Materials and Lubricants: Store in cool and dry location free of oil, grease, excessive heat and direct sunrays.

C. Handling:
1. General: Comply with manufacturer's recommendations and as noted.
2. Aggregates: Handle to prevent segregation.
3. Pre-cast Concrete Structures: Handle to prevent damage. Utilize lifting holes provided by structure manufacturer.

1.7 DEFINITIONS:

A. Refer to Section 31 20 00 "Earthmoving".

1.8 PROJECT CONDITIONS:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Traffic: Maintain pedestrian and vehicular traffic during utility construction operations.

C. Limitations:

1. Environmental: Do not place Portland cement products or erect masonry when ambient air temperature is below 40 degrees Fahrenheit or air temperature has been below 35 degrees Fahrenheit for twelve or more consecutive hours or between 15 November and 01 March without written authorization from the Owner's Representative or the Architect.

D. Certifications, Inspections and As-Built Documents:
1. The Contractor shall provide inspection, certification and "as-built" plans of the on-site water, sanitary sewer service and storm sewer work by a registered professional Engineer. Contractor shall notify the Architect within 15 calendar days of signing the contract who the Maryland Registered P.E. will be and who will certify the as-built water and sewer plan. Show any changes and include ties for the location of valves, bends, manholes, fire hydrants, and laterals accompanied by the qualifying air test date and certification of compliance. See Division One "Project Record Documents" for format of "as-built" drawings.

2. All stormwater management and storm drain system work must be inspected by Prince George's County in accordance with agency permit requirements. Record of as-built conditions will be required.

PART 2 - PRODUCTS:

2.1 MATERIALS:

A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.

B. Portland Cement Concrete: SHA Section 902, Portland Cement Concrete and Related Products.
1. Water: Clean and free of oil, acid and injurious amounts of vegetable matter, alkalis and salts. River, stream or lake water is prohibited.
2. Forms: Wood, steel or as specified. Form materials to produce smooth surfaces, free of irregularities. Nonrented wood formwork shall be made of FSC-certified sustainably harvested wood materials.

C. Mixes:
1. Class "A" Concrete: SHA Mix No. 4, Table 902 A. 28-Day compressive strength 3500 P.S.I. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.
2. Class "B" Concrete: SHA Mix No. 2, Table 902 A. 28-Day compressive strength 3000 P.S.I. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.

D. Concrete Reinforcements:
1. Steel bars: ASTM A 615, Grade 60, deformed, designation as indicated or specified. Minimum 99% recycled-content, of which minimum 60% shall be post-consumer and the remainder may be post-industrial material.

2. Steel Wire Mesh: ASTM A 185 welded wire mesh, roll type, size as indicated or specified.

E. Brick:
1. Type A: ASTM C 55 Concrete Building Brick, type I, grade N, standard manufacture size.
2. Type B: ASTM C 32 Clay or Shale Brick, grade SS or as specified, solid, 2-1/4 by 3-3/4 by 8 inches.

F. Cement Mortar: SHA Section 902.05, Masonry Cement.
1. Water: As specified for Portland cement concrete.

G. Cast-in-Place Reinforced Concrete Structures:
1. Structure Bases: Class "B" Portland Cement Concrete.
2. Structure Walls and Top Slabs: Class "A" Portland Cement Concrete.
3. Concrete Reinforcement, Structural Steel, Structure Castings and Appurtenances: As indicated and specified.

H. Pre-Cast Reinforced Concrete Structures:
1. Square and Rectangular Structures: ASTM C 858.
2. Structural Design Loading: ASTM C 858, live load designation A-16.
3. Circular Structures: ASTM C 478.
4. Structure Joints: ASTM C 443.

I. Foundation Materials:
1. Type I: ASTM C 33 Coarse Aggregate, size No. 8 (3/8 inch to No. 8).
2. Type II: SHA Coarse Aggregate Size No. 57 stone (1 1/2 inch to No. 8).
3. Type III: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay, rocks or stones exceeding 1 inch in any dimension. Obtain Type III material from on-site excavations or off-site borrow areas approved by the Soils Engineer.

J. Bedding Materials:
1. Type A: ASTM C 33 Fine Aggregate.
2. Type B: ASTM C 33 Coarse Aggregate, size No. 6 (1 inch to No. 4).
   a. Contractor's Option: SHA Coarse Aggregate Size No. 57 stone (1 1/2 to # 8.)
   b. Recycled concrete RC-6 may, at Contractor's discretion, be used for bedding in approved locations.
3. Type C: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay and rocks or stones exceeding one inch in any direction.

K. Bedding Material Schedule:
1. Storm drainage system: Type B, or as per manufacturers recommendations.
2. Water Distribution System: W.S.S.C. Standards, or Type A.
3. Sanitary Sewer System: W.S.S.C. Standards, or Type B.
4. All other utilities: Type C.

L. Backfill Materials: As specified for Fill or Backfill, Section 31 20 00 "Earthmoving", and as noted.
1. Utility Trenches:

a. Phase I: Earth material free of debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding one inch in any dimension.
b. Phase II: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension.

2. Utility Structures: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension. Obtain backfill material from the following: Excavated material approved by the Soils Engineer or the Owner's Representative.

PART 3 - EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. General: Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Cut off timber when using timber support systems above top of utility to prevent utility displacement. Exercise care when using trench shields or boxes during shield movement to prevent utility displacement.

3.2 EXISTING UTILITIES:

A. Refer to Section 31 20 00 "Earthmoving", and as noted. Contractor shall notify "Miss Utility" at least 48 hours prior to start of construction.

B. Provide test pits at all existing utility crossings prior to any system construction. Verify utility inverts for review by Architect or the Owner's Representative to determine potential conflicts prior to start of system construction.

3.3 DEWATERING:

A. Refer to Section 31 20 00 "Earthmoving".

3.4 EXCAVATION:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Trench Excavation: Open cut method or as specified. Excavate materials encountered to subgrade elevations indicated or specified.

1. Trench width below top of utility not to exceed the following clearances on each side of utility:

2.

Utility Exterior Width, Diameter or Span	Clearance
1 thru 30 in.	16 in.
31 and higher	24 in.

3. Excavate utility trenches to the following depths:
   a. Circular storm drainage pipe: Six inches below bottom of pipe.
   b. Water distribution pipe: W.S.S.C. Standards or four inches below bottom of pipe.

c. Sanitary sewer pipe: W.S.S.C. Standards or six inches below bottom of pipe.
d. All other utilities: Bottom of utility.

C. Structure Excavation:
1. Utility structure excavation to produce 12-inch clearance between exterior structure walls and excavation walls or support systems.
2. Extend excavation to the following:
a. Cast in place reinforced concrete structures: Six inches beyond structure base.
b. Pre-cast reinforced concrete structures: Six inches below bottom of pre-cast structure base.
c. Pre-cast reinforced concrete structure with cast in place concrete base: Bottom of structure base.
d. Masonry structures: Bottom of structure base.

3.5 OVER-EXCAVATION:

A. Refer to Section 31 20 00 "Earthmoving", except as noted.

B. Utility Trenches:
1. Correct over-excavation of water distribution, storm drainage and gravity flow sanitary sewer systems by backfilling over-excavated trenches with Type II foundation (Type B bedding) material and compacting.
2. Correct over-excavation of all other utilities by backfilling over-excavated trenches with Type III foundation (Type C bedding) material and compacting.
3. Place material in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density. Density test method: ASTM D 698.

C. Structures: Correct utility structure over-excavation by backfilling over-excavation with Type II foundation (Type B bedding) material and compacting.
1. Place material in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density. Density test method: ASTM D 698.

3.6 UNSUITABLE EARTH:

A. Refer to Section 31 20 00 "Earthmoving", except as noted.

B. Restore unsuitable earth excavation as specified for over-excavation.

3.7 EXCAVATED MATERIAL STORAGE:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Stockpile select excavated materials required for backfill operations.

3.8 PORTLAND CEMENT CONCRETE CONSTRUCTION:

A. Mixing:
1. Ready-Mixed Concrete: ASTM C 94.
2. Project Site Batch Mixing: ACI 301, Chapter 7.

B. Formwork: ACI 301, Chapter 4.

C. Reinforcement: ACI 301, Chapter 5.

D. Joints and Embedded Items: ACI 301, Chapter 6.

E. Placement: ACI 301, Chapter 8.

F. Surface Defects: ACI 301, Chapter 9.

G. Finishes: ACI 301. Non-Exposed: Section 10.2.1. Exposed: Section 10.2.2.

H. Curing and Protection: ACI 301, Chapter 12.

I. Cold Weather Concreting: ACI 306R.

J. Hot Weather Concreting: ACI 305R.

3.9 STRUCTURES:

A. Cast in Place Reinforced Concrete Structures: Construct cast in place concrete structures as indicated and specified.

B. Pre-cast Reinforced Concrete Structures:
1. Pre-cast structure base: Place Type I foundation material, on excavation subgrade, to bottom of structure base and compact to 98 percent of maximum dry density by ASTM D 698. Install pre-cast structure base, on compacted foundation material, level to 1/8 inch in 5 feet. Clean and lubricate structure joints, immediately prior to installation, in accordance with manufacturer's recommendation. Install pre-cast reinforced structure sections, on structure base, plumb to 1/4 inch in 10 feet. Position structure sections on previously installed section and push joints tightly together. Position concrete top slabs on structure as indicated. Plug lifting holes with cement mortar. Install frames and covers to finished grade with bricks and cement mortar.

C. Masonry Structures:
1. Erect structure walls with masonry materials specified. Wet each masonry unit thoroughly before placement. Shove each unit into place in full bed of cement mortar. Horizontal and vertical joints not to exceed 1/2 inch.
2. Bond and Coursing: Brick Masonry - Common Bond.
3. Fill joints completely with cement mortar. Fit masonry units tightly around utilities projecting through structure walls. Space, set and bond structure appurtenances as indicated or specified during masonry erection. Point up interior structure joints and clean removing excess cement mortar. Parge exterior structure walls with 1/2 inch thick cement mortar and finish with smooth trowel. Masonry construction tolerances not to exceed 1/4 inch in 10 feet vertical from plumb.

3.10 BEDDING:

A. Storm drainage pipe: Place bedding material, on excavated trench subgrade to bottom of pipe

and compact. Upon completion of pipe installation, place and compact bedding material to springline of pipe.

B. All Other Utilities: Bedding not required. Install utilities on excavated trench subgrade as indicated or specified.

3.11 BACKFILL:

A. Backfill utility trenches in two consecutive phases as follows:
1. Phase I - Backfill to 12-inch depth above top of utility. Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 1557.
2. Phase II - Unpaved Areas: Place backfill material to grade in loose lifts not exceeding 8 inches. Compact each lift to 85 percent maximum dry density. Density test method: ASTM D 1557
3. Phase II - Paved Areas: Place backfill material to grade in loose lifts not exceeding eight inches. Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 1557.

B. Backfill utility structures as follows: Place backfill material carefully and in loose lifts not exceeding 12 inches (paved areas - 8 inches) in depth. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698. Do not backfill masonry structures until cement mortar parge attains initial set.

3.12 EXCAVATED MATERIAL DISPOSAL:

A. Refer to Section 31 20 00 "Earthmoving".

3.13 WASTE MANAGEMENT:

A. Recycle waste materials in accordance with Division 1 "Construction Waste Management" requirements.

END OF SECTION

SECTION 33 10 05 - WATER DISTRIBUTION SYSTEM

PART 1 – GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct water distribution system.

1.3 RELATED WORK:

A. Refer to Section 33 10 00 "Utility Standards".

1.4 STANDARDS:

A. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".

B. Washington Suburban Sanitary Commission's current "Regulations Governing the Installation of Plumbing and Sewer Cleaning in the Washington Suburban Sanitary District".

C. American Water Works Association (AWWA).

1.5 SUBMITTALS:

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include W.S.S.C. Contract Number or On-site number, job location, Contractor's name, types, classes and strengths of pipe and fittings, and the Manufacturer's name.

C. Submit As-built drawings to the Architect.

D. Service Connection Permit: Contractor shall submit to Architect all items required by WSSC to obtain a Service Connection Permit, including but not limited to: All required WSSC Bonds, Letter indicating Utility Contractor, and Certificate of Insurance. The Architect will obtain the Service Connection Permit once all these items are received.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

1.7 PROJECT CONDITIONS:

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Jurisdiction Standards: Site is located within WSSC jurisdiction. On-site fire hydrants shall be "Supervised Fire Hydrants".

C. All on-site construction and materials shall be in accordance with the latest edition of the W.S.S.C. General Conditions and Standard Specifications, Design Manual, Standard Details and Plumbing and Gasfitters Regulations.

1.8 CONSTRUCTION SURVEYS:

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 50 feet and at all appurtenances (e.g. fittings, valves, etc.). Provide construction cut sheet preparation as required.

PART 2 - PRODUCTS:

2.1 MATERIALS:

A. All materials shall be W.S.S.C. Standards and shall meet all W.S.S.C. requirements indicated.

B. Valve Boxes: Cast iron two-piece valve boxes, screw type box, bell base section, 5-1/4 inch shaft, round drop cover with "W" marking.

2.2 FIRE HYDRANTS:

A. WSSC Standard.

2.3 CONCRETE PADS: Class 'A' Portland cement.

2.4 CONCRETE ANCHORS: W.S.S.C. Standards indicated and specified. Class 'A' Portland cement concrete, Section 33 10 00 "Utility Standards".

2.5 STRAPS AND RODS:

A. Clamps, Straps and Washers: Steel, ASTM A 506.

B. Rods: Steel, ASTM A 575.

C. Rod Couplings: Malleable-Iron, ASTM A 197

D. Bolts: Steel, ASTM A 307

E. Cast-Iron Washers: Gray-iron, ASTM A 126

2.6 MISCELLANEOUS PRODUCTS:

A. Underground Identification Tape: Manufactured by Allen Systems, Houston, Texas.
1. Type: "Markline".
2. Color: Precaution Blue.
3. Legend: Caution water line buried below.
4. Tape Width: Three inches.

B. Disinfection Products: W.S.S.C. standards indicated and specified. For continuous feed disinfection method, use Calcium Hypochlorite: AWWA B 300, granular form.
1. Contractor's Option: AWWA B 301 Liquid Chlorine.
2. Contractor's Option: AWWA B 303 Sodium Chloride.
3. Water: Potable.

PART 3 - EXECUTION:

3.1 PROTECTION AND RESTORATION:

A. Refer to Section 33 10 00 "Utility Standards".

3.2 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

A. Refer to Section 33 10 00 "Utility Standards".

3.3 PIPE:

A. General:
1. Install in accordance with pipe manufacturer's installation instructions, W.S.S.C. standards and requirements and as noted.
2. Inspect each pipe laying length, pipe joint materials and fittings for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Place fittings at changes in horizontal and vertical alignment as indicated. Construct concrete anchors at each fitting as indicated. Place concrete to permit access to joints for inspection and maintenance. Apply liberal coat of coal tar pitch to exposed steel and hardware. Field cut pipe only where required to complete closures or to install fittings, valves or fire protection equipment. Cut pipe to smooth square end with equipment designed for cutting pipe.

B. Ductile Iron Pipe:
1. Install pipe in accordance with AWWA C 600 and as noted.
2. Install with bell ends facing in direction of laying operations. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed upgrade. Place identifying mark on pipe not provided with spigot depth mark. Clean interior and exterior surfaces of bell and spigot removing oil, grit, excess coating and foreign matter. Lubricate pipe ends and gasket in accordance with pipe manufacturer's instruction.

C. Ductile Iron Push-On Pipe: Position each laying length in previously installed pipe and push or pull joint tightly together with mechanical device designed for pipe jointing. Grind or file spigot end of field cut pipe to resemble manufactured spigot end. Place spigot identifying

depth mark as specified. Pipe joint deflection not to exceed the limits specified in Table 2, AWWA C 655.

3.4 BURIED VALVES:

A. Install valves in accordance with valve manufacturer's installation instructions, and W.S.S.C. requirements.

3.5 FIRE HYDRANTS:

A. General: Install fire hydrants at locations indicated, in accordance with AWWA M17 "Installation, Operation and Maintenance of Fire Hydrants", manufacturer's installation instructions, and W.S.S.C. standards and requirements.

3.6 BACKFILL:

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Watermain's 4-inches and larger must be inspected by the Architect prior to completion of backfill operations. Contractor shall provide a minimum of 48 hours notice to the Architect before completion of backfill operations.

C. Valve Box Installation: Install valve box for each buried gate valve during backfill operations. Install boxes to prevent shock or stress transmission to valves or pipe and center over valve operating nut plumb to 1/4 inch in five feet. Adjust box cover flush to finished grade.

D. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered over pipe, located 24 inches below finished grade.

3.7 SYSTEM TESTING:

A. General: Provide materials, equipment (e.g. pumps, gauges, etc.) and labor required to test system. Do not conduct tests until concrete anchors cure and set seven calendar days. Provide a minimum of 48 hours notification of planned testing. Test observation by local governing water authority personnel. Test system in accordance with AWWA C 600 and as noted.

B. Hydrostatic Pressure Tests: Conduct hydrostatic pressure tests, upon completion of Phase I backfill operations. Fill systems or valved section of system with water. Expel air from pipe. Slowly apply test pressure. Test pressure to be per approved plan. Test duration to be two hours. Test pressure shall not vary more than +5 psi for the duration of the test. Examine all system joints. Correct defective products or improper system installation as directed by the local governing water authority personnel.

C. Hydrostatic Leakage Tests: Conduct hydrostatic leakage tests upon completion of Phase II backfill operations. Test procedure as specified for hydrostatic pressure tests, except as noted. Test duration 24 hours. Allowable leakage for ductile iron pipe is not to exceed the limits specified in Table 3, AWWA C 600. Correct system installation exceeding allowable leakage

specified as directed by the local governing water authority personnel.

3.8 INSPECTION AND CERTIFICATION:

A. Retain the services of a Maryland-Registered Professional Engineer for inspection of system construction and certification that system complies with standards specified. In accordance with the requirements on the approved WSSC drawings, the inspecting engineer must be the engineer of record for the approved WSSC drawings.

3.9 SYSTEM DISINFECTION:

A. Disinfect system in accordance with AWWA C 651, W.S.S.C. standards specified, and as noted. Provide materials, equipment (e.g. pumps, etc.) and labor required to disinfect system.

B. Disinfection Method: Continuous feed.

1. Preliminary and final flushing velocity to be 2.5 fps. Solution concentration as specified. Maintain 50 MG/L available chlorine during 24-hour disinfection period. Bacteriologic test interval every six hours. Flushing and drainage locations where directed by the Owner's Representative.

3.10 DISINFECTION TESTING:

A. Conduct chlorine residual tests upon completion of final flushing operations. Repeat disinfection operation until satisfactory chlorine residual quality tests are obtained.

3.11 WATER BACTERIOLOGIC QUALITY TESTING:

A. Retain the services of an independent testing laboratory to conduct water bacteriologic quality testing.

END OF SECTION

SECTION 33 30 00 - SANITARY SEWERAGE

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct gravity flow sanitary sewer system.

1.3 RELATED WORK:

A. Refer to Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards", Section 33 41 00 "Storm Drainage", and Division 26 "Plumbing".

1.4 STANDARDS:

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".

C. Washington Suburban Sanitary Commission's current "Regulations Governing the Installation of Plumbing and Sewer Cleaning in the Washington Suburban Sanitary District".

1.5 SUBMITTALS:

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include W.S.S.C. Contract Number or On-site number, job location, Contractor's name, types, classes and strengths of pipe and fittings, and the Manufacturer's name.

C. Options: Submit typewritten list of selected products when options are specified within 10 calendar days after contract execution. Submit detailed shop drawings of system modifications required by selection of options.

D. Submit shop drawings of precast structures indicating concrete reinforcement location, size and placement.

E. Submit As-built drawings to the Architect.

F. Service Connection Permit: Contractor shall submit to Architect all items required by WSSC to obtain a Service Connection Permit including but not limited to: All required WSSC Bonds, Letter indicating Utility Contractor, and Certificate of Insurance. The Architect will obtain the Service Connection Permit once all these items are received.

1.6 PRODUCT, DELIVERY, STORAGE AND HANDLING:

A. Refer to Section 33 10 00 "Utility Standards".

1.7 PROJECT CONDITIONS:

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. All on-site construction and materials shall be in accordance with the latest edition of the W.S.S.C. General Conditions and Standard Specifications, Design Manual, Standard Details and Plumbing and Gasfitters Regulations.

C. Existing Sanitary Sewer System: Provide, install, operate and maintain pumps and related equipment required to divert sewage (bypass pumping) during system construction. Extend pump discharge lines to existing sanitary sewer structures. Surface flow is prohibited.

D. Traffic: Maintain vehicular and pedestrian traffic during system construction.

1.8 CONSTRUCTION SURVEYS:

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

PART 2 - PRODUCTS:

2.1 MATERIALS:

A. All materials shall be W.S.S.C. Standards and shall meet all W.S.S.C. requirements indicated.

B. Polyvinyl Chloride (PVC) Pipe: W.S.S.C. Standards indicated. ASTM D 3034, SDR 35 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.
1. Pipe Joints: ASTM D 3212 bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.
2. Fittings shall be as indicated and required.

C. Cleanouts: W.S.S.C. standards indicated.
1. Cleanouts For Use in Paved Walk Areas: Refer to Section 33 41 00 "Storm Drainage", and as noted.
   a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
2. Furnish the Owner with one cleanout wrench.

D. Structures: W.S.S.C. standards specified and indicated.

E. Foundation and Bedding Materials: Refer to Section 33 10 00 "Utility Standards".

F. Concrete: Refer to Section 33 10 00 "Utility Standards".

G. Miscellaneous Products:
1. Underground identification type manufactured by Allen Systems, Houston, Texas. "Detectatape" type, three inches wide, marked "Caution Sewer Line Buried Below", "Safety Green" color.

PART 3 - EXECUTION:

3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

A. Refer to Section 33 10 00 "Utility Standards".

3.2 EXISTING SYSTEM CONNECTION:

A. Notify WSSC no less than 48 hours prior to the start of system construction.

B. Excavate and expose existing pipe at connection location indicated. Adjust connection location, as required, in the event of conflicts with existing pipe joints. Neatly cut existing pipe and prepare cut end as required for connection with new pipe. Make connections with existing pipe using fittings designed for the purpose, in accordance with manufacturer's installation instructions.

3.3 PIPE:

A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin with installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end with equipment designed for cutting pipe.

B. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.
1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.
2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.

3.4 EXISTING PIPE/STRUCTURE CONSTRUCTION:

A. Excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Architect or Owner's Representative in the event existing pipe joint interferes with structure walls, or as required to obtain required invert, at no increase to contract sum. Manually excavate below existing pipe prior to structure base placement. Place concrete structure base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.

3.5 STRUCTURES:

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Pipe Connections: Install pipe opening sleeves in accordance with manufacturer's installation instructions. Neatly cut pipes flush with interior structure walls except as otherwise indicated or specified.

C. Structure Joints: Apply liberal coat of joint coating material to each structure section joint in accordance with manufacturer's application instructions.

D. Invert Flow Channels: Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curve radii as large as structure will permit. Neatly form channels in structure base with bricks and cement mortar.

3.6 CLEANOUTS:

A. Refer to Section 33 41 00 "Storm Drainage", and as noted.

B. Install cleanouts in accordance with manufacturer's installation instructions and as indicated.
1. Construct concrete pads of Class "A" concrete as indicated.
2. Cleanouts in paved walk shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

3.7 BACKFILL:

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Sanitary Sewer mains must be inspected by the Architect prior to completion of backfill operations. Contractor shall provide a minimum of 48 hours notice to the Architect before completion of backfill operations.

C. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered over pipe, located 12 inches above top of pipe.

3.8 SYSTEM TESTING:

A. Provide equipment, materials and labor required to test system. Conduct low pressure air tests

in accordance with local jurisdiction approving agency standards. Provide a minimum of 48 hours notification of planned testing. Test observation by W.S.S.C. personnel.

B. Repair or replace defective products and system construction, which fails tests as directed by local jurisdiction approving agency. Provide additional corrective work and retesting until system is approved and accepted. Provide corrective work and retesting at no increase to contract sum.

END OF SECTION

SECTION 33 41 00 - STORM DRAINAGE

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, Specifications Section, apply to work in this section.

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct storm drainage system.

1.3 RELATED WORK:

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards"; Section 32 13 13 "Cement Concrete Paving" and Division 22 "Plumbing".

1.4 STANDARDS:

A. Washington Suburban Sanitary Commission (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".

B. Prince George's County Department of Transportation current "Design Standards".

C. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials".

D. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.

E. American Concrete Pipe Association (ACPA).

F. Cast Iron Soil Pipe Institute (CISPI).

1.5 SUBMITTALS:

A. Products:
1. Submit certificate signed by manufacturer and contractor stating that pipe and pipe joint materials comply with this specification.
2. Submit shop drawings of pre-cast reinforced structures and cast in place reinforced concrete structures indicating location, size and placement of concrete reinforcement.
3. Submit manufacturer's descriptive literature of cleanouts.
4. Submit location of product manufacture.

1.6 PROJECT CONDITIONS:

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Storm Drainage System: Provide, install, operate and maintain pumps and related

equipment required to divert storm water during system construction.

C. Traffic: Maintain pedestrian and vehicular traffic during system construction.

D. As-Built Documents:
1. Refer to Section 33 10 00 "Utility Standards

1.7 CONSTRUCTION SURVEYS:

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

PART 2 - PRODUCTS:

2.1 MATERIALS:

A. General: Provide products manufactured within a 500-mile radius of the Project Site

B. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, Schedule 40 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.
1. Pipe Joints: ASTM D 3212, bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.
2. Fittings shall be as indicated and required.

C. Cast Iron Soil Pipe: ASTM A 74, extra heavy, coal tar coating, size as indicated, standard manufacture laying length.
1. Pipe Joints and Fittings: ASTM A 74, hub and spigot joint type manufactured for rubber gaskets. Rubber gaskets per ASTM C 564. Joint lubricant of vegetable oil soap. Fitting types as indicated or required.

D. Concrete Pipe: ASTM C 76, Class IV, standard manufacture laying length.
1. Pipe Joints: Rubber gaskets, ASTM C 443 with vegetable oil soap joint lubricant.
2. Mortar Joints: Modified tongue and groove pipe with cement mortar.

E. Corrugated Steel Pipe: ASTM A 819 and AASHTO M 274 Aluminized Steel Type 2 pipe, corrugations and thickness as specified on plans.
1. Pipe Joints: Shall be watertight joints, made with bands gaskets as specified on plans.

F. High Density Polyethylene Pipe: ADS Type N-12, or approved equal.
1. Pipe Joints: All joints must meet a modified ASTM 3212 at 3.5-psi held for 10 minutes as certified by an independent testing laboratory.
2. Pipe Joints: Plastic Cement Welding Solvents shall have a VOC content not to exceed 250 g/l.

G. Structures: Standards specified and as indicated.

H. Structure Castings: MDOT-SHA or Prince George's County Standards.
1. Grates for storm drain inlets with grate tops shall be waffle shaped for wheel chair and bicycle safety. Slots shall not exceed 4" by 1 1/2".

I. PVC Pipe for Infiltration Drywell: Schedule 40 Polyvinyl Chloride (PVC) sewer pipe as indicated and required by Prince George's County.
1. Size: As indicated.
2. Perforations: Drill 1/4-inch perforations all around for entire length as indicated.
3. Fittings: As indicated and required.

J. Cleanouts:
1. Cleanout Ferrules and Plugs: Josam Series No. 58490 with cast iron body and bronze countersunk flanged plug. Size matching pipe size indicated. Contractor shall provide Owner with two "T" handles for recessed plugs.
2. Cleanouts For Use in Paved Walk Areas: Josam Series No. 58360 adjustable floor cleanout with cast iron body and bronze plug and top. Size matching pipe size indicated. Contractor shall provide Owner with one cleanout wrench.
a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
3. Fittings: Shall be as specified for PVC pipe (for pipe materials indicated).

K. Filter Fabric: "Mirafi 140N" manufactured by Mirafi Incorporated, Charlotte, North Carolina. Contractor's Option: "Typar", type 3341 manufactured by Remay Incorporated, Nashville, Tennessee, or approved equal.
1. Quality: Free of defects of flaws, which affect strength or filtering properties.

L. Sand: ASTM C33 Fine Aggregate.

M. Concrete: Refer to Section 33 10 00 "Utility Standards".

N. Reinforcing Steel and Hardware: Refer to Section 33 10 00 "Utility Standards", and as noted:
1. Size and type of steel and hardware shall be as indicated.
2. Exposed reinforcing steel shall be hot dip galvanized, ASTM A 767, Coating Class I.
3. Hardware shall be hot dip galvanized, ASTM A 153.

O. Miscellaneous Products:
1. Underground identification tape manufactured by Allen Systems, Houston, Texas. Tape shall be three inches wide, "Detectatape" type, "Safety Green" color, and marked "Caution Sewer Line Buried Below".

PART 3 - EXECUTION:

3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

A. Refer to Section 33 10 00 "Utility Standards".

3.2 CONNECTIONS TO EXISTING SYSTEM:

A. For structure construction over existing pipe, excavate and expose existing pipe at structure

location indicated. Adjust structure location as directed by the Owner's Representative in the event existing pipe joint interferes with structure walls, at no increase to Contract Sum. Manually excavate below existing pipe prior to structure base placement. Place concrete base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.

B. For pipe connections to existing structures, excavate and expose existing structure. Cut and remove portion of existing structure wall required for pipe connection. Install pipe, through existing structure wall, flush with interior wall surface. Remove portion of existing invert flow channel required for connection and reconstruct as specified. Fill joint between pipe and existing structure wall with cement mortar.

3.3 PIPE:

A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end.

B. Cast Iron Pipe: Install with spigot end of pipe pointing in direction of flow. Install fittings where indicated or required. Clean and lubricate joints, immediately prior to joining pipe, in accordance with manufacturer's recommendation. Position each laying length in previously installed pipe and push joint tightly together.

C. Concrete Pipe: Install with tongue end of pipe pointing in direction of flow. Clean and thoroughly wet joints immediately prior to joining pipe. Apply thick liberal coat of mastic to groove and tongue. Position each laying length in previously installed pipe and pull joint tightly together with mechanical device designed for pipe jointing.
1. Clean interior of each joint removing excess cement mortar and finish flush with surface. Fill exterior upper half of pipe joint with cement mortar.

D. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.
1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.
2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.

E. Corrugated Steel Pipe: Install in accordance with manufacturer's recommendations and instructions, and ASTM A 798.

F. High Density Polyethylene Pipe: Install in accordance with manufacturer's recommendations.

3.4 CLEANOUTS:

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Install cleanouts and construct concrete pads of Class "A" concrete as indicated.

C. Cleanout in paved walk area shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

3.5 STRUCTURES:

A. Refer to Section 33 10 00 "Utility Standards" and as noted. Neatly cut pipes flush with interior structure walls. Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curves, with radii as large as structure will permit or as indicated. Neatly form channels in structure base with bricks and cement mortar. Provide steps in structures exceeding 3.0 feet in depth. Vertical step spacing per standards specified.

3.6 BACKFILL:

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Polyvinyl Chloride (PVC) Pipe: Conduct backfill operations when pipe temperature is below 60 degrees Fahrenheit or during early morning hours to prevent excessive contraction.

C. Underground Identification Tape: Install during backfill operations. Center tape horizontally over pipe, 12 inches above top of pipe.

3.7 WASTE MANAGEMENT:

A. Recycle waste piping materials in accordance with Division 1 "Construction Waste Management" requirements.

END OF SECTION