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PROJECT MANUAL

Tioga Downs Racetrack LLC Reception Center

Project Manual Volume II

THE DESIGN OF THIS PROJECT CONFORMS TO ALL APPLICABLE PROVISIONS OF THE NEW YORK STATE UNIFORM FIRE PREVENTION AND BUILDING CODE AND THE NEW YORK STATE ENERGY CONSERVATION CODE

ISSUE FOR BID: APRIL 15, 2024

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BASIC FIRE SUPPRESSION MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe, fittings, valves, and connections for water-based fire protection systems.

1.2 REFERENCES

A. Building Code of New York State (2020 edition)

B. Fire Code of New York State (2020 edition)

C. NFPA 13 - Installation of Sprinkler Systems-current edition

D. NFPA 14- Standpipe Systems, current edition

E. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems- current edition

F. NFPA 70, National Electrical Code (current edition)

G. NFPA 72, National Fire Alarm Code (current edition)

H. Underwriters Laboratories UL Fire Protection Equipment Directory (current edition)

1.3 SUBMITTALS

A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and be specifically identified with the applicable manufacturer name and series number.

B. Product Data: Submit manufacturer’s catalogue information. Indicate valve data and ratings.

C. Test Reports: Indicate procedures and results for specified field-testing and inspection.

D. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

E. Qualifications: NICET certification or PE registration

1.4 CLOSEOUT SUBMITTALS

A. Execution Requirements: Closeout procedures as indicated in division 1 of these specifications.

B. Project Record Documents: Record actual locations of components and tag numbering.

C. Operation and Maintenance Data: Submit manufacturer's standard operating and maintenance instructions.

D. Maintenance: Submit schedule of preventative maintenance inspections/testing and outline of what inspections/testing shall occur.

E. Reports: Submit contractor's material and test certificate for above ground piping.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products as specified

B. Installer: Company specializing and licensed in performing work of this section with minimum five years documented experience and NICET (National Institute for Certification in Engineering Technologies) certified.

C. System shall be arranged and installed under the supervision of a NICET Level III certified sprinkler technician

D. Provide firestopping at all penetrations required to complete the scope of work for sprinkler systems.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Furnish cast ductile iron and steel valves with temporary protective coating.

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

1.7 MAINTENANCE SERVICE

A. Furnish service and maintenance of the system components for one year from the Date of Substantial Completion.

PART 2 – PRODUCTS

2.1 All equipment shall be UL listed and FM approved for fire protection service. Minimum 250 psi water working pressure.

2.2 VALVES AND COMPONENTS

A. Gate Valves - Comply with UL 262:

1. Up to and including 2 inches: Bronze body and trim, rising stem, hand wheel, solid wedge or disc, threaded ends.
1. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged ends.
2. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, and iron body indicator post assembly.
3. All control valves shall be provided with tamper switches to be installed by the Contractor and wired to building fire alarm system.
4. All equipment shall be UL listed and FM Approved for fire protection service.

B. Globe Valves:
   1. Up to and including 2 inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity.
   2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

C. Ball Valves:
   1. Up to and including 2 inches: Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, Teflon seats and stuffing box ring, lever handle or brass gearbox and iron hand wheel, balancing stops, threaded ends with union, or grooved ends with grooved joint couplings and pre-wired supervisory switches.
   2. Over 2 inches: Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle or gear drive hand wheel for sizes 10 inches and over, flanged.

D. Butterfly Valves – Comply with UL 1091:
   1. Up to and including 6 inches: bronze body, stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, hand wheel and gear drive and integral indicating device, and built-in tamper proof switch rated 24 volt DC.
   2. Cast or Ductile Iron Body: Cast or ductile iron, chrome, nickel plated, or EPDM coated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends. With extended neck, hand wheel and gear drive and integral indicating device and external tamper switch rated 24 volt DC, and weatherproof actuator, rated to 300 psi.
   3. All control valves with integral tamper switches to be installed by the Contractor and wired to building fire alarm system.

E. Check Valves – Comply with UL 312:
   1. Up to and including 2 inches: Bronze body and swing disc, rubber seat, threaded ends.
   2. Over 2 inches:
      a. Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.
      b. Ductile iron body, aluminum bronze single disc design with spring-assisted feature for non-slamming operation, stainless steel spring and shaft, synthetic rubber seat, grooved ends.
   3. 4 inches and Over:
      a. Iron body, bronze disc with stainless steel spring, resilient seal, threaded, wafer, or flanged ends.
      b. Ductile iron body, elastomer encapsulated ductile iron single disc design with spring-assisted feature for non-slamming operation, stainless steel spring and shaft, welded-in nickel seat, grooved ends, designed to accept a riser check kit.

F. Drain Valves:
   1. Compression Stop: Bronze with hose thread nipple and cap.
   2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.
   3. Test and Drain Valve: Globe design, bronze body and bonnet, bronze and copper alloy internals with stainless steel spring, dual polycarbonate sight glasses, with integral orifice simulating a sprinkler head, grooved or threaded ends.

2.3 PIPING

A. Above Ground Steel Pipe: Piping shall be schedule 40 black steel pipe for diameters 2 in. and less, and schedule 10 for diameters larger than 2 in. (galvanized where indicated) and shall comply with UL 852 and applicable provisions of ASTM A53.

1. Outlets on pipe 2 inches and larger shall be shop welded or mechanical tee fittings with grooved or threaded connections.

2. Mechanical Couplings: Manufactured in two segments of cast ductile iron conforming to ASTM A536, Grade 65-45-12. Gaskets shall be pressure-responsive, synthetic rubber, grade to suit the intended service and comply with UL 213. Bolts and nuts shall be zinc-plated carbon steel conforming to ASTM A183 and A449.
    a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13.
        1) 1-1/4" to 4": "Installation Ready" rigid joints which shall be designed for direct "stab" installation onto grooved pipe without prior disassembly of the coupling.
        2) 5" and Larger: Standard rigid joints for systems requiring higher pressure ratings.
    b. Flexible Type: For use in locations where vibration attenuation and stress relief are required.
3. Mechanical Coupling Gaskets: Pressure-responsive, synthetic rubber, listed for use with the housings that comply with UL 213:

Fire protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	Grade EPDM, Type A
Freezer Applications	-40 ºF. to 0 °F	Grade L, Silicone
Water/ Wet Systems	Ambient	Grade EPDM, Type A

4. Flange Adapters: For use with grooved end pipe and fittings, flat face, for mating to ANSI Class 125 and 150 flanges.
5. Grooved End Fittings (2-1/2 in. diameter and larger): Fittings shall be short radius, full flow, cast ductile iron conforming to ASTM A536 or forged steel conforming to ASTM A234, or fabricated carbon steel conforming to ASTM A53, with factory grooved ends designed to accept couplings.
6. Outlets on pipe 1-1/2 inches and smaller shall be joined by threaded fittings.
7. Fittings for Non-Grooved Steel Pipe (2 in. diameter and larger): Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9, or ASME B16.11, or malleable iron conforming to ASME B16.3. Galvanized fittings shall be used for piping systems or portions of piping systems utilizing galvanized piping. Fittings into which sprinklers, drop nipples, or riser nipples (sprigs) are screwed shall be the threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, and segmented welded fittings shall not be used.
8. All pipe shall be supported from the building structure in accordance with NFPA 13

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. All pipe hangers and their components shall be ferrous.

B. All hangers shall be substantially supported by the building structure. Fire protection piping shall be supported independently of any ceiling sheathing. Do not hang from the underside of roofing deck or from other equipment or materials.

C. Trapeze hangers shall be used where necessary to transfer loads to appropriate building structural members. Multiple or trapeze Hangers shall be construction/supported of steel channels with welded spacers and hanger rods.

D. Where fire protection piping is installed below ductwork, piping shall be supported from the building structure or from the ductwork supports, provided the ductwork supports are capable of handling the load of the ductwork and the load specified in paragraph A above. Submit calculations and owner approval if this method is to be employed.

E. Fire protection piping or hangers shall not be used to support non-system components. Advise all other contractors working in the building of this.

F. The maximum distance between hangers and the minimum number of hangers for fire protection piping shall be in accordance with NFPA 13.

G. All pipe risers shall be supported by pipe clamps or by hangers located on the horizontal connections within 24" of the centerline of the riser. Pipe clamps supporting risers by means of set screws shall not be used. The distance between supports for risers shall not exceed 25 feet. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

H. Hanger Rods:
1. Hanger rod sizes shall be as follows:
   a. Up to and including 4" pipe: 3/8" diameter rod
   b. 5" through 8" pipe: ½" diameter rod
   c. 10" and 12" pipe: 5/8" diameter rod
2. Threaded sections of rods shall not be formed or bent.

I. Hanger Fasteners:

1. Acceptable fasteners for steel, wood, and concrete include but are not limited to: Ceiling flanges, side beam attachments, concrete inserts, expansion shields, power driven studs, coach screw rods etc.
2. All hangar fasteners shall meet the requirements of and be installed in conformance with NFPA 13.

J. Hangar Types and Applications:
1. Hangers for Pipe Sizes 1" to 6": Carbon steel, adjustable swivel ring band hangar with surge restrainer.
2. Hangers for Pipe Sizes larger than 6" and Over: Carbon steel, adjustable, clevis.
3. Horizontal Wall Support for Pipe Sizes Up to 4" and Over: Welded steel bracket and wrought steel clamp.
4. Vertical Support: Steel riser clamp, split rings, and/or offset pipe clamps.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Rigid type grooved joint mechanical couplings with angle-pattern bolt pads, may be used on IPS steel piping systems, which meet the support and hanging requirements of NFPA 13. An adequate numbers of flexible type couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

K. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.

L. Place hangers within 12 inches of each horizontal elbow.

M. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

N. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges, grooved joint couplings, or unions.

3.2 INSTALLATION

A. Route piping in orderly manner plumb and parallel to building structure. Maintain gradient.

B. Connection of fire alarm initiating devices (flow switches, tamper switches, fire pump supervisory signals, etc.) will be by electrical trades contractor.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. All wall and floor through penetrations for fire protection piping shall be fully sleeved and sealed. Sleeve shall be a minimum of schedule 40 steel and protrude a minimum of 4 inches on either side of wall or floor surface with a trim ring. All penetrations through fire rated assemblies shall be appropriately fire stopped with a U.L. rated system in accordance with specification Section 07840. All fire stopping materials/sealants shall be the low emitting VOC type. Submit information from fire stopping material manufacturer ensuring their materials have low emitting VOC characteristics. The contractor applying firestopping implements/materials shall be FM 4991 approved and shall conduct all work in accordance with U.L. and FCIA standards.

F. Installation of cleated (screw type) flanges on any piping is prohibited. Do not use grooved mechanical type connections on the service side of building alarm valve. Use only welded or threaded and flanged connections.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level. If “trapped pipe” conditions are unavoidable install auxiliary drains.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Do not penetrate building structural members unless indicated.

K. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

L. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

M. Install valves with stems upright or horizontal, not inverted. All system water supply control valves shall have tamper switches provided and integrated into the fire alarm system as a supervisory signal. Remove protective coatings after installation.

N. Install gate or butterfly valves for shut-off or isolating service. All system valves shall have tamper switches provided and integrated into the fire alarm system as a supervisory signal.

O. Install drain valves at main shut-off valves, low points of piping and apparatus. Main drains and end of line drains to the building exterior shall be provided. Drains shall have cast in place concrete splash blocks or a similar method to control runoff and erosion at the building exterior.

P. Fire protection drains shall be terminated at the exterior and provided with concrete splash blocks or a similar method to control runoff and erosion at the building exterior. Drains shall not be terminated at sumps, floor drains or hub drains.

Q. Pipe Joints: Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. The diameter of grooves made in the field shall be measured using a "go/no go" gauge, vernier, or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls, unless an access panel is provided for servicing or adjusting the joint. Threaded joints shall not have more than four threads showing after the joint is made up. Welded joints are permitted only if welding operations are performed in accordance with NFPA 13 at the contractor's fabrication shop, and not at the project construction site. A factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

R. Reducers: Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face type are permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction size is less than ½ inch.

S. Underground fire service piping and supply mains shall be thoroughly flushed at a flow rate adequate to achieve a minimum 10 ft/s flow velocity prior to connection to backflow preventers. Introduction of rocks, dirt or other foreign materials into interior fire protection piping shall be corrected at no additional expense to the Owner. Furnish NFPA 24 flushing and testing certificates.

T. Perform full forward flow test of backflow preventers at the calculated fire protection flow rate

U. Fire protection piping shall not be routed directly over the top of main electrical equipment or switchgear.

3.3 FIELD QUALITY CONTROL

V. Final Acceptance/Commissioning Test: The system will be accepted only after satisfactory test of the entire system has been accomplished by the Contractor. All new and existing piping and attached appurtenances subject to system working pressure shall be hydrostatically tested at either 200 psi or 50 psi in excess of normal system pressure if greater than 175 psi and shall maintain that pressure without loss for 2 hours. Additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals shall not be used for testing systems or stopping leaks.

W. Piping between the exterior fire department connection and the check valve in the fire department inlet pipe shall be hydrostatically tested in the same manner as the balance of the system.

X. The Contractor shall provide all necessary, calibrated test equipment in order to conduct all functional tests as outlined above.

Y. Contractor shall submit all completed test forms attached to this specification and submit copies to all parties.

3.4 3.5 DEMONSTRATION AND TRAINING

A. The Contractor shall provide a minimum of 2 hours of instruction and operation, and maintenance of all elements of the materials and methods specified above for “non-technician” personnel prior to the commissioning of the building fire suppression system. All training shall take place prior to final acceptance testing of the system. The Contractor shall provide written notification 72 hours prior to the commencement of testing. Failure to contact the above parties will require the Contractor to conduct training a second time at the contractor’s expense in the presence of the above parties.

B. Instruction shall be provided by a material or system manufacturer’s certified representative familiar with the equipment and special operating requirements of the system provided and the Owner’s operating procedures.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Summary:

1. Basic plumbing requirements specifically applicable to Division 22 sections, in addition to Division 1 - General Requirements
2. General requirements for motors, hangers and supports, vibration isolation and seismic restraints.

B. Submittals: Product Data for materials and equipment specified in this Section.

1.2 DOCUMENTS

A. The general provisions of this Contract, including the bidding and Contract requirements, Division 0, Division 1, schedules, addenda, and modifications apply to the work of this Division.

B. Drawings and Specifications are supplementing each other. Work shown but not specified, or specified but not shown, shall be performed or furnished as though present in both Drawing and Specifications.

C. Related specifications

1. General construction work

1.3 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate electrical requirements with Division 26 Contractor.

D. Work is indicated diagrammatically on Drawings. Follow routing shown for duct and pipe as closely as practicable; place runs parallel with lines of building. Provide bends, offsets, and transitions as necessary to avoid conflicts with structure, finished surfaces, and other trades. Coordinate space requirements and utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs. Resolve conflicts with other trades before proceeding. If conflicts cannot be resolved, notify Owner's Representative.

E. In finished areas except as otherwise indicated, conceal duct and piping within the construction. Coordinate location of fixtures and registers with finish elements.

F. Coordinate completion and cleanup of Work of separate sections in preparation for Completion and for portions of Work designated for Owner's occupancy.

A. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

2.2 CUTTING AND PATCHING

A. Provide cutting and patching for work of this Division.

B. Patch openings left by abandoned equipment, duct, and pipes.

C. Patch shall match existing finishes.

2.3 DISPOSAL

A. All material indicated for removal, or required to be removed to complete the work, shall be disposed of in accordance with Federal, state, and local regulations.

2.4 FIRESTOPPING

A. Provide fire-stopping wherever required for all penetrations.

2.5 ACCESS PANELS

A. Coordinate with the General Contractor for locations of wall and ceiling mounted access panels.

B. Access panels are furnished and installed by General Contractor unless noted otherwise.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. Hanger and Pipe Attachments: Factory fabricated with galvanized coatings; nonmetallic coated for hangers in direct contact with copper tubing.

B. Building Attachments: Powder-actuated-type, drive-pin attachments with pullout and shear capacities appropriate for supported loads and building materials.

C. Mechanical-Expansion Anchors: Insert wedge-type attachments with pullout and shear capacities appropriate for supported loads and building materials.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATIONS

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

B. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.

C. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.

D. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.

E. Install unions at final connection to each piece of equipment.

F. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.

G. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

H. Cap piping remaining following removals with fittings designed for permanent use. All terminations shall be in concealed locations except in mechanical and utility spaces, unless otherwise noted.

3.2 GENERAL EQUIPMENT AND FIXTURE INSTALLATIONS

A. Provide blocking per manufacturer's recommendations to support wall mounted fixtures. Where not specified by the manufacturer, provide a minimum of ¾" plywood securely attached to framing members with sufficient strength to support the intended weight. The plywood backing shall encompass the entire area of contact between the fixture and the wall.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

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

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

3.3 HANGERS AND SUPPORTS

A. Install piping free of sags and bends. Provide horizontal support at spacing as follows:
   1. Steel pipe
      a. Up to 1 inch: 8 feet
      b. 11/4 inch to 2 inches: 10 feet
      c. Over 2 inches: 12 feet
   2. Copper tube
      a. Up to 1 inch: 6 feet
      b. 1-1/4 inch to 2 inches: 8 feet
      c. Over 2 inches: 10 feet
   3. Non-metallic pipe
      a. Up to 1 inch: 4 feet
      b. 1-1/4 inch to 2 inches: 6 feet
      c. Over 2 inches: 8 feet

B. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.

C. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.

D. Install powder-actuated drive-pin fasteners in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.

E. Install mechanical-expansion anchors in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.

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

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
   1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of uninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of uninsulated stationary pipes, NPS 1/2 to NPS 8.
   4. Adjustable Band Hangers (MSS Type 9): For suspension of uninsulated stationary pipes, NPS 1/2 to NPS 8.
   5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of uninsulated stationary pipes, NPS 1/2 to NPS 2.

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

   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

3.4 PAINTING

A. Paint all new exposed and uncoated or uninsulated iron work and piping, including galvanized material, with primer and two coats of Rustoleum paint. Wire brush iron work to remove rust prior to painting.

B. Color to be determined by Owner or Architect.

3.5 RECORD DRAWINGS

A. The Contractor shall maintain a set of record documents clearly indicating all changes from the contract drawings to be use in creating as-built drawings.

3.6 CLOSE OUT REQUIREMENTS

A. In addition to any or all requirements listed in Division 1 specifications, the following are required to be submitted to the Architect/Engineer:
   1. As-built drawing markup.
   2. Copy of all Valve Charts.
   3. Operation and Maintenance Manual.
   4. Report of final plumbing inspection.

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe markers.

1.2 RELATED REQUIREMENTS

A. Section 09 90 00 - Painting and Coating: Identification painting.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007 (ANSI/ASME A13.1).

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.4 SUBMITTALS

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

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Operation and Maintenance, O&M, Manual Data: Record actual locations of tagged valves, and provide laminated valve chart which includes valve tag numbers, location and function in chart form for placement into Operations and Maintenance Manual.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Piping: Pipe Markers, Stencils.

B. Water Heater: Nameplates.

C. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.
   3. Background Color: Red.
   4. Plastic: Conform to ASTM D709.

2.3 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

B. Valve Tag Chart: Typewritten letter sized list, plastic laminated. Typewritten letter size list to include applied tag function description, valve tag number and location.

2.4 STENCILS (CONCEALED PIPING)

A. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
   2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors conforming to ASME A13.1.

2.5 PIPE MARKERS (EXPOSED PIPING)

A. Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Identify water heaters and water treatment devices with plastic nameplates.

D. Apply stencil painting in accordance with Section 09 90 00.

E. Install plastic pipe markers in accordance with manufacturer's instructions.

F. Use tags on piping 3/4 inch diameter and smaller.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.

3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

H. Identify concealed piping, with stenciled painting. Identify exposed piping with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Identify valves in main and branch piping with tags.

END OF SECTION

SECTION 22 07 19

PIPING INSULATION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Through Penetration Firestops: Section 078400.

B. Painting: Section 099103.

C. Pipe Hangers and Supports: Section 220529.

1.02 ABBREVIATIONS

A. FS: Federal Specification.

B. K: Thermal Conductivity, i.e., maximum Btu per inch thickness per hour per square foot.

C. pcf: Pounds per cubic foot.

D. PVC: Polyvinylchloride.

1.03 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, specifications and installation instructions for the following:
   1. Insulation Materials.
   2. Jacket Materials.

B. Quality Control Submittals:
   1. Installers Qualification Data:
      a. Name of each person who will be performing the Work, and their employer's name, business address and telephone number.
      b. Furnish names and addresses of the required number of similar projects that each person has worked on which meet the qualifications.

1.04 QUALITY ASSURANCE

A. Qualifications: The persons installing the Work of this Section and their Supervisor shall be personally experienced in mechanical insulation work and shall have been regularly employed by a company installing mechanical insulation for a minimum of 5 years.

B. Regulatory Requirements:
   1. Insulation installed inside buildings, including laminated jackets, mastics, sealants and adhesives shall have a Fire Spread/Smoke Developed Rating of 25/50 or less based on ASTM E 84.

PART 2 PRODUCTS

2.01 PIPING INSULATION

A. Fibrous Glass (Mineral Fiber) Insulation: Composed principally of fibers manufactured from rock, slag, or glass, with or without binders, and asbestos free.
1. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547:
a. Class 1 (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
2. Premolded Fitting Insulation: Minimum density 4.0 pcf, K of 0.26 at 75 degrees F; ASTM C 547, Class 1.
3. Insulation Inserts for PVC Fitting Jackets: Minimum density 1.5 pcf, K of 0.28 at 75 degrees F; ASTM C 553, Type III.
a. Suitable for temperatures up to 450 degrees F.

B. Flexible Elastomeric Foam Insulation:
1. FM tested and approved, meeting the following:
a. Maximum Water Vapor Transmission: 0.10 perm - inch based on ASTM E 96, Procedure A.
b. K of 0.27 at 75 degrees F based on ASTM C 518 or C 177.
c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E 84.
2. Pipe Insulation: ASTM C 534, Type I.
3. Polyethylene and polyolefin insulation is not acceptable.

C. High Density Jacketed Insulation Inserts for Hangers and Supports:
1. For Use with Fibrous Glass Insulation:
a. Cold Service Piping:
1) Polyurethane Foam: Minimum density 4 pcf, K of 0.13 at 75 degrees F, minimum compressive strength of 125 psi.
b. Hot Service Piping:
1) Calcium Silicate: Minimum density 15 pcf, K of 0.50 at 300 degrees F; ASTM C 533.
2) Perlite: Minimum density 12 pcf, K of 0.60 at 300 degrees F; ASTM C 610.
2. For Use with Flexible Elastomeric Foam Insulation: Hardwood dowels and blocks, length or thickness equal to insulation thickness, other dimensions as specified or required.

D. Cements:
1. Fibrous Glass Thermal Insulating Cement: Asbestos free; ASTM C 195.
2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 INSULATION JACKETS

A. Laminated Vapor Barrier Jackets for Piping: Factory applied by insulation manufacturer, conforming to ASTM C 1136, Type I.
1. Type I: Reinforced white kraft and aluminum foil laminate with kraft facing out.
a. Pipe Jackets: Furnished with integral 1-1/2 inch self sealing longitudinal lap, and separate 3 inch wide adhesive backed butt strips.

2. Laminated vapor barrier jackets are not required for flexible elastomeric foam insulation.

B. Canvas Jackets: Cotton duck, fire retardant, complying with NFPA 701, 4 oz or 6 oz per sq yd as specified.

C. Premolded PVC Fitting Jackets:
1. Constructed of high impact, UV resistant PVC.
a. ASTM D 1784, Class 14253-C.
b. Working Temperature: 0-150 degrees F.

D. Metal Jacketing:
1. Aluminum: ASTM B 209, Alloys 1100, 30003, 3105 or 5005, Temper H14, 0.016 inch thick.
a. Factory Pre-formed Sectional Pipe Jacketing:
1) Smooth outer finish with integral bonded laminated polyethylene film - kraft paper moisture barrier underside.
2) Pittsburgh or modified Pittsburgh longitudinal lock seams.
3) 2 inch overlapping circumferential joints with integral locking clips, or butt joints sealed with 2 inch wide mastic backed aluminum snap bands.
b. Fastening Devices:
1) Strapping: Type 18-8 stainless steel, 0.020 inch thick, 1/2 and 3/4 inch wide as specified.
2) Wing Seals: Type 18-8 stainless steel, 0.032 inch thick.
3) Sheet Metal Screws: Panhead, Type A, hardened aluminum, and stainless steel.

E. Under Lavatory Piping Protection Cover: ADA compliant.
1. Construction: 1/8 inch thick chemical, microbial, and fungal resistant, injection molded smooth PVC vinyl with internal ribs.
2. Fasteners: Reusable, finger press internal fasteners presenting no sharp or abrasive external surfaces.
3. Cover Trimming: Tear on internal, dimensioned tear lines for proper fit.
4. Kit includes covering for 8 inch tailpiece-trap, 8 inch waste arm, hot and cold water supplies and valves, and required fasteners.
5. Acceptable Covers:
a. Lav Guard 2, E-Z Series by IPS Corp., 202 Industrial Park Lane, Collierville, TN 38017, (800) 340-5969, www.truebro.com.
b. Pro-Extreme Series by Plumberex, P.O. Box 1684, Palm Springs, CA 92263, (800) 475-8629, www.plumberex.com.

2.03 ADHESIVES, MASTICS, AND SEALERS

A. Lagging Adhesive (Canvas Jackets): Childers' CP-50AMV1, Epolux's Cadalag 336, Foster's 30-36.

B. Vapor Lap Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-60 or 85-20.

C. Vapor Barrier Mastic(Fibrous Glass Insulation): Permeance shall be .03 perms or less at 45 mils dry per ASTM E 96. Childers' CP-34, Epolux's Cadalar 670, Foster's 30-65.

D. Adhesive (Flexible Elastomeric Foam): Armstrong's 520, Childers' CP-82, Epolux's Cadoprene 488, Foster's 85-75. 5 gallon cans only

E. Adhesive (Fiberglass Duct Liner): Childers' Chil Quick CP-127, Foster Vapor Fas 85-60. Must comply with ASTM C 916, Type II

F. Weather Barrier Breather Mastic (Reinforcing Membrane): Childers' VI-CRYL CP-10/11, Foster's Weatherite 46-50.

G. Sealant (Metal Pipe Jacket): Non hardening elastomeric sealants. Foster Elastolar 95-44, Childers Chil Byl CP-76, Pittsburgh Corning 727

H. Reinforcing Membrane: Childers' Chil Glas #10, Foster Mast a Fab, Pittsburgh Corning PC 79

2.04 MISCELLANEOUS MATERIALS

A. Pressure Sensitive Tape for Sealing Laminated Jackets:
1. Acceptable Manufacturers: Alpha Associates, Ideal Tape, Morgan Adhesive.
2. Type: Same construction as jacket.

B. Wire, Bands, and Wire Mesh:
1. Binding and Lacing Wire: Nickel copper alloy or copper clad steel, gage as specified.
2. Bands: Galvanized steel, 1/2 inch wide x 0.015 inch thick, with 0.032 inch thick galvanized wing seals.
3. Wire Mesh: Woven 20 gage steel wire with 1 inch hexagonal openings, galvanized after weaving.

C. Reinforcing Membrane: Glass or Polyester, 10 x 10 mesh. Alpha Associates Style 59, Childer's Chil-Glas, Foster's MAST-A-FAB.

PART 3 EXECUTION

3.01 PREPARATION

A. Perform the following before starting insulation Work:
1. Install hangers, supports and appurtenances in their permanent locations.
2. Complete testing of piping.
3. Clean and dry surfaces to be insulated.

3.02 INSTALLATION, GENERAL

A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions unless otherwise specified.

B. Provide continuous piping insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
1. At Through Penetration Firestops: Coordinate insulation densities with the requirements of approved firestop system being installed. See Section 07 84 00.

a. Insulation densities required by approved firestop system may vary with the densities specified in this Section. When this occurs use the higher density insulation.

C. Do not intermix different insulation materials on individual runs of piping.

3.03 INSTALLATION AT HANGERS AND SUPPORTS

A. Reset and realign hangers and supports if they are displaced while installing insulation.

B. Install high density jacketed insulation inserts at hangers and supports for insulated piping.

C. Insulation Inserts For Use with Fibrous Glass Insulation:
1. Where clevis hangers are used, install insulation shields and high density jacketed insulation inserts between shield and pipe.
a. Where insulation is subject to compression at points over 180 degrees apart, e.g. riser clamps, U-bolts, trapezes, etc.; fully encircle pipe with 2 protection shields and 2 high density jacketed fibrous glass insulation inserts within supporting members.
1) Exception: Locations where pipe covering protection saddles are specified for hot service piping, 6 inch and larger.

D. Insulation Inserts For Use with Flexible Elastomeric Foam Insulation:
1. Where clevis hangers are used, install insulation shields with hardwood filler pieces, same thickness as adjoining insulation, inserted in undersized die cut or slotted holes in insulation at support points.
2. Contour hardwood blocks to match the curvature of pipe, and shield.
3. Coat dowels and blocks with insulation adhesive, and insert while still wet.
4. Vapor seal outer surfaces of dowels and blocks with adhesive after insertion.
5. Install filler pieces as follows:

PIPE/TUBING SIZE	FILLER PIECES	POSITION
Thru 1-1/2”	2 dowel plugs	6 o’clock; in tandem
2” thru 4”	1 block, 2 dowel plugs	6 o’clock, and 4 & 8 o’clock respectively
6” thru 8”	2 blocks, 4 dowel plugs	6 o’clock; in tandem and 4 & 8 o’clock; in tandem

3.04 INSTALLATION OF FIBROUS GLASS COLD SERVICE INSULATION

A. Install insulation materials with a field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket, unless otherwise specified.

B. Piping:
1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self-sealing longitudinal jacket laps and 3-inch wide butt adhesive backed strips.

a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as jacket, may be used in lieu of butt strips.

2. Bed insulation in a 2-inch wide band of vapor barrier mastic, and vapor seal exposed ends of insulation with vapor barrier mastic at each butt joint between pipe insulation and equipment, fittings or flanges at the following intervals:
   a. Horizontal Pipe Runs: 21 ft.
   b. Vertical Pipe Runs: 9 ft.

C. Fittings, Valves, Flanges and Irregular Surfaces:
1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as pipe insulation.
2. Secure insulation in place with 16-gage wire, with ends twisted and turned down into insulation.
3. Butt insulation against pipe insulation and bond with joint sealer.
4. Insulate valves up to and including bonnets, without interfering with packing nuts.
5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
6. When insulating cement has dried, seal fitting, valve and flange insulation, by imbedding a layer of reinforcing membrane or 4 oz. canvas jacket between 2 flood coats of vapor barrier mastic, each 1/8 inch thick wet.
7. Lap reinforcing membrane or canvas on itself and adjoining pipe insulation at least 2 inches.
8. Trowel, brush or rubber glove outside coat over entire insulated surface.
9. Exceptions:
   a. Type C and D Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.
      1) Additional insulation inserts are required for services with operating temperatures under 45 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not go below 45 degrees F.

3.05 INSTALLATION OF FIBROUS GLASS HOT SERVICE INSULATION

A. Install insulation materials with field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket unless otherwise specified.

B. Canvas Jackets on Piping, Fittings, Valves, Flanges, Unions, and Irregular Surfaces:
1. For Piping 2 inch Size and Smaller: 4 oz per sq yd unless otherwise specified.
2. For Piping Over 2 inch Size: 6 oz per sq yd unless otherwise specified.

C. Piping:
1. Butt insulation joints together, continuously seal minimum 1-1/2 inch wide self-sealing longitudinal jacket laps and 3-inch wide adhesive backed butt strips.
   a. Substitution: 3 inch wide pressure sensitive sealing tape, of same material as the jacket, may be used in lieu of butt strips.
2. Fill voids in insulation at hanger with insulating cement.
3. Exceptions:

a. Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Spaces and Concealed Piping: Butt insulation joints together and secure minimum 1-1/2 inch wide longitudinal jacket laps and 3 inch wide butt strips of same material as jacket, with outward clinching staples on maximum 4 inch centers. Fill voids in insulation at hangers with insulating cement.

D. Fittings, Valves, Flanges and Irregular Surfaces:
1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as insulation.
2. Secure in place with 16-gage wire, with ends twisted and turned down into insulation.
3. Butt fitting, valve and flange insulation against pipe insulation, and fill voids with insulating cement.
4. Insulate valves up to and including bonnets, without interfering with packing nuts.
5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
6. After insulating cement has dried, coat insulated surface with lagging adhesive, and apply 4 oz or 6 oz canvas jacket as required by pipe size.
   a. Lap canvas jacket on itself and adjoining pipe insulation at least 2 inches.
   b. Size entire canvas jacket with lagging adhesive.
7. Exceptions:
   a. In Types E, and F Service Piping Systems: Valves, fittings and flanges may be insulated with premolded PVC fitting jackets, with fibrous glass insulation inserts.
      1) Additional insulation inserts are required for services with operating temperatures over 250 degrees F or where insulation thickness exceeds 1-1/2 inches. The surface temperature of PVC fitting jacket must not exceed 150 degrees F.
   b. In Types E, and F Service Piping Systems: Insulate fittings, valves, and irregular surfaces 3 inch size and smaller with insulating cement covered with 4 oz or 6 oz canvas jacket as required by pipe size.
      1) Terminate pipe insulation adjacent to flanges and unions with insulating cement, trowelled down to pipe on a bevel.
   c. Fittings, Valves, Flanges, and Irregular Surfaces In Concealed Piping, Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Rooms, Unfinished Spaces, and Tunnels: Sizing of canvas surface is not required.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC FOAM INSULATION

A. Where possible, slip insulation over the pipe, and seal butt joints with adhesive.
1. Where the slip-on technique is not possible, slit the insulation and install.
2. Re-seal with adhesive, making sure the mating surfaces are completely joined.

B. Insulate fittings and valves with miter cut sections. Use templates provided by the manufacturer, and assemble the cut sections in accordance with the manufacturer's printed instructions.
1. Insulate threaded fittings and valves with sleeved fitting covers. Over lap and seal the covers to the adjoining pipe insulation with adhesive.

C. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier of the system.

D. Piping Exposed Exterior to a Building, Totally Exposed to the Elements:
1. Apply flexible elastomeric foam insulation to piping with adhesive.
2. Apply reinforcing membrane around piping insulation with adhesive or mastic.
3. Adhesive Applied System: Apply 2 coats of finish. See Section 099103.
4. Mastic Applied System: Apply another coat of mastic over reinforcing membrane.

3.07 INSTALLATION OF SHEET METAL JACKETING ON PIPING

A. Secure jacketing to insulated piping with preformed aluminum snap straps and stainless steel strapping installed with special banding wrench.

B. Jacket exposed insulated fittings, valves and flanges with mitred sections of aluminum jacketing.
1. Seal joints with sealant and secure with preformed aluminum bands.
3. Substitution: Factory fabricated, preformed, sectional aluminum fitting covers or premolded polyvinylchloride fitting covers may be used in lieu of mitred sections of aluminum jacketing for covering fittings, valves and flanges.

3.08 FIELD QUALITY CONTROL

A. Field Samples: The Director's Representative, may at their discretion, take field samples of installed insulation for the purpose of checking materials and application. Reinsulate sample cut areas.

3.09 PIPING INSULATION SCHEDULE

A. Insulate all cold service and hot service piping, and appurtenances except where otherwise specified.

B. Schedule of Items Not to be Insulated:
1. Chrome plated piping, unless otherwise specified.
2. Exposed piping in finished spaces, serving one fixture, or piece of equipment, and which connection from the main, branch, or riser, is 24 inches or less in length.
3. Water heater blow-off piping.
4. Air vents, pressure reducing valves, pilot lines, safety valves, relief valves.
5. Water meters.
6. Piping buried in the ground, unless otherwise specified herein.
7. Items installed by others, unless otherwise specified herein.
8. Sanitary drainage piping, unless otherwise specified herein.
9. Mechanical equipment with factory applied steel jacket.
10. Hot service piping 81 degrees F to 104 degrees F.
11. Flanges and unions in Type E, F, and G service piping systems.
12. Sprinkler and standpipe piping, unless otherwise specified.

3.10 COLD SERVICE INSULATION MATERIAL SCHEDULE

TYPE	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
C	Fluids (except domestic cold water) 40 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	1-1/2 & less Over 1-1/2	1 1-1/2
D	Domestic cold water, and as specified. 33 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	All Sizes	1/2

A. NOTES:
1. Sprinkler and Standpipe Piping (First 10 feet connected to domestic water main within building): Insulate with same materials and thicknesses specified for domestic cold water.
2. Roof Drain Bodies Below Roof, Horizontal Conductor Piping Including Drops, and First Fitting on Vertical conductor: Insulate with same materials and thicknesses specified for domestic cold water.
3. Piping Serving Handicapped Accessible Lavatories:
   a. Insulate exposed hot water supply and waste piping with flexible elastomeric foam pipe insulation.

3.11 HOT SERVICE INSULATION MATERIAL SCHEDULE

	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
E	Water and other fluids 105 F to140 F.	Flex. Elastomeric Foam or Fibrous Glass	1-1/2 & Less Over 1-1/2	1 2
F	Water and other fluids 141 F to 250 F.	Fibrous Glass	6 & Less 8 & Up	2 2-1/2

A. NOTES:
1. Insulate piping in tunnels and conduits with insulation of thickness as follows:
   a. Types E, and F Service: Minimum 2 inch thick unless greater thickness is specified in Hot Service Insulation material Schedule above.

3.12 SCHEDULE OF METAL JACKETING FOR INSULATED PIPE

1. The aforementioned also applies to down feed piping systems.

END OF SECTION

SECTION 22 10 05
PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe, pipe fittings, valves, connections and specialties for:
   1. Sanitary sewer systems.
   2. Domestic water systems.
   3. Gas systems.
   4. Flanges, unions, and couplings.
   5. Pipe hangers and supports.
   6. Valves.
   7. Flow controls.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.

C. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

E. Section 22 07 19 - Plumbing Piping Insulation.

F. Section 31 23 23 - Fill.

G. Section 31 23 16.13 - Trenching.

1.3 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers; 2011.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.

D. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2012.

E. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.

F. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2014 (ANSI/ASME B31.9).

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

H. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2015.

I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.

J. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

K. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV); 2002.

L. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2014.

M. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2012.

N. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2014.

O. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2014.

P. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).

Q. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2014.

R. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2015.

S. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40; 2015.

T. ASTM F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2013.

U. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2013.

V. ASTM F442/F442M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR); 2013.

W. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2010.

X. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2014.

Y. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2010 (ANSI/AWWA C105/A21.5).

Z. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2012 (ANSI/AWWA C111/A21.11).

AA. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; American Water Works Association; 2009 (ANSI/AWWA C151/A21.51).

AB. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).

AC. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2009.

AD. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2011

AE. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.

AF. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.

AG. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.

AH. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.

AI. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

AJ. NFPA 58 - Liquefied Petroleum Gas Code; National Fire Protection Association; 2014.

AK. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015).

AL. NSF 372 - Drinking Water System Components - Lead Content; 2011.

AM. National Sanitation Foundation: NSF 61 - Low lead pipe, Fittings and Valves.

1.4 SUBMITTALS

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

B. Product Data: Provide data on pipe materials, pipe fittings, valves, hangers, supports and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

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

D. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of New York, standards.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.6 REGULATORY REQUIREMENTS

A. Perform Work in accordance with State of New York plumbing code.

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

C. Protect CPVC piping and accessories by storing indoors.

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.4 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 extra heavy weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

B. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.5 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D2665 or ASTM D3034
   1. Fittings: PVC
   2. Joints: Solvent welded, ASTM D2564 solvent cement.

2.6 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET **OF BUILDING**

A. Ductile Iron Pipe: AWWA C151/A21.51, 3 inches and larger.
   1. Fittings: AWWA C110, ductile iron, standard thickness. Cement Mortar lining in conformance with AWWA C-104.
   2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch diameter rods.
   3. Jackets: AWWA C105 polyethylene jacket.

B.

2.7 DOMESTIC WATER PIPING, ABOVE GRADE

A. CPVC Pipe for Potable Water Systems: ASTM D2846/D2846M, ASTM F441/F441M, or ASTM F442/F442M.
   1. FlowGuard Gold CPVC Piping and Fittings, Compatible with Potable water system and NSF lead free certified.
   2. Fittings: CPVC; ASTM D2846/D2846M, ASTM F437, ASTM F438, or ASTM F439.
   3. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement. NSF labeled.

2.8 GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40, Type E or S, Grade B, black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, brass to iron seat, ground joint, and threaded ends.
2. Joints: NFPA 58, threaded or welded to ASME B31.1.

B. Exterior gas piping above grade:
1. Apply one coat of rust inhibitive primer paint and one finish coat of paint per manufacturer's recommendation. Rust preventive enamel, OSHA approved. Color to be coordinated with Owner.

2.9 COMPRESSED AIR PIPING

A. Steel Pipe: ASTM A53/a 53M, Type E or S, Grade B, black with ends threaded according to ASME B1.20.1.
1. Steel Nipples: ASTM A733, made of ASTM A53/A 53M or ASTM A-106, Schedule 40 galvanized seamless steel pipe, include ends matching joining method.
2. Malleable Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Steel Fances: ASME B16.5, Class 150 or 300, carbon steel, threaded.
5. Wrought-Steel Butt Welding Fittings: ASME B16.9, Schedule 40.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

B. Copper Tube: ASTM B88, Type K or L Seamless, drawn-temper, water tube.
1. Wrought Copper Fittings: ASME B16.22, solder joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
2. Cast Copper Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.

C. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating a least equal to, and ends compatible with, piping to be joined.

2.10 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes [2] inches and Under:
1. Copper tube and pipe: Class 150 bronze unions with soldered joints.
2. PVC Piping: PVC
3. CPVC Piping for Potable Water System: PVC

B. Flanges for Pipe Size Over 2 inches:
1. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
3. PVC Piping: PVC
4. Gaskets: 1/16 inch thick preformed neoprene gaskets

2.11 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers, Clamps, Straps, Guide and Restraints used on domestic CPVC piping must be chemically compatible with CPVC CTS Flowguard Gold piping and fittings.
3. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
4. Trapeze Hangers: Welded steel channel frames attached to structure.
5. Vertical Pipe Support: Steel riser clamp.
6. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

B. Plumbing Piping - Drain, Waste, and Vent:
   1. Conform to ASME B31.9.
   2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
   7. Vertical Support: Steel riser clamp.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
   1. Hangers, Hanger Fasteners, Clamps, Straps, Guide, Wall Supports, Vertical Supports, Floor Supports and Restraints used on domestic CPVC piping must be chemically compatible with CPVC CTS Flowguard Gold piping and fittings per manufacturers recommendations.

D. INSERTS
   1. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

E. FLASHING
   1. Metal Flashing: 26 gage thick galvanized steel.
   2. Metal Counterflashing: 22 gage thick galvanized steel.
   3. Lead Flashing:
      a. Waterproofing: 5 lb./sq. ft sheet lead.
      b. Soundproofing: 1 lb./sq. ft sheet lead.
   4. Flexible Flashing: 47 mil thick sheet compatible with roofing.
   5. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

F. SLEEVES
   1. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.
   2. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
   3. Sealant: refer to Section 07 90 00.

G. MECHANICAL SLEEVE SEALS
   1. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

H. FIRESTOPPING
   1. Refer to Specification Section 07 84 00.

2.12 BALL VALVES

A. Manufacturers:
   1. Nibco, Inc.
   2. Spears EverTuff CTS CPVC for Potable Water system.
   3. Milwaukee Valve Company; _
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Construction, 3 inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two-piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder or threaded ends with union. Lead free.

C. Compatible with Potable water system CPVC piping and NSF lead free certified.

2.13 FLOW CONTROLS

A. Compatible with Potable water system CPVC piping and NSF lead free certified.

2.14 HORIZONTAL SWING CHECK VALVES

A. Compatible with Potable water system CPVC piping and NSF lead free certified.

2.15 HOSE BIBBS

A. Hose Bibb, HB-1: Interior use, rough chrome plated brass construction, wall mounted for concealed cold water and hot water service with hose thread spout, integral stop valves, vacuum breaker, lever handles.

B. Hose Bibb, HB-2: Interior use, rough chrome plated brass construction, wall mounted for exposed cold water and hot water service with hose thread spout, integral stop valves, v acuum breaker, lever handles.

2.16 WATER HAMMER ARRESTOR

A. Stainless steel bellow type, complies with and sized in accordance with PDI WH-201.

B. Pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.17 FLOOR DRAIN / FLOOR SINK

A. Floor Drain, FD-1, FD-2: ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, 1/2 inch trap primer connection, reversible clamping collar, and round adjustable nickel-bronze strainer.

B. Floor Sink, FS-1: 12 inch x 12 inch x 6 inch floor receptor, full grate, enamel interior and top, interior bottom dome strainer and 1/2 inch trap primer connection.

C. Floor Drain / Floor Sink Trap Primer Valve: ASSE 1018, corrosion resistant brass, piston operated, no springs or diaphragms, adjustable in line pressure, 1/2 inch inlet and outlet openings.

2.18 CLEANOUTS

A. Cleanout, Interior Unfinished Inline Accessible Area, CO-1: cast iron body ferrule type with ABS countersunk plug.

B. Cleanout, Interior Finished Floor Area, CO-2: cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round polished bronze scored cover.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

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

B. Remove scale and dirt, on inside and outside, before assembly. Protect open ends with temporary plugs or caps.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Provide connection from CPVC piping to Plumbing Fixtures per piping manufacturers recommendations.

D. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

E. Install piping to maintain headroom, conserve space, and not interfere with use of space.

F. Group piping whenever practical at common elevations.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.

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

I. Provide access where valves and fittings are not exposed.

J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Backfill in accordance with Section 31 23 23.

M. Trench - Provide 3 inches of sand for bedding material at trench bottom to provide uniform bedding for piping. Level bedding materials and install pipe on prepared bedding. Encase installed piping with 6 inches of pea gravel. Provide fill material to trench and compact to 90 percent maximum density. Route pipe in straight line.

N. Install bell and spigot pipe with bell end upstream.

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

P. Install water piping to ASME B31.9.

Q. CPVC Pipe: Make solvent-welded joints in accordance with ASTM F493 and ASTM F402.

R. Sleeve pipes passing through partitions, walls and floors.

S. PVC piping is not allowed to be installed in places of assembly, plenum spaces, exit discharge corridors or stairs. Use cast iron or copper piping in these locations.

T. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

U. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to fixtures to prevent hammer or install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch minimum, and minimum 18 inches long.

V. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

W. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 05 48.
9. Support cast iron drainage piping at every joint.

X. Flashing
1. Provide flexible flashing and metal counterflashing where piping penetrates roof.
2. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size.
3. Flash floor drains / floor sinks, floor cleanouts in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
4. Seal floor, shower, and mop sink drains watertight to adjacent materials.

AA. Sleeves
1. Set sleeves in position in forms. Provide reinforcing around sleeves.
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
3. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
4. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with fire stopping, insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
5. Install chrome plated steel escutcheons at finished surfaces.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Provide flow controls in water recirculating systems where indicated.

3.5 TOLERANCES

A. Sanitary Drainage Piping: Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum on mains 4 inches and larger. Install branch mains smaller than 4 inch with 1/4 inch per foot minimum.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 33 13 00.

B. Final water samples shall be sent to a New York State Department of Health approved testing lab and sample test results shall be submitted to A/E of record.

C. Prior to starting work, verify system is complete, flushed and clean.

D. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

F. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

G. Maintain disinfectant in system for 24 hours.

H. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

I. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

J. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.7 SERVICE CONNECTIONS

A. Test sanitary waste and vent piping system in accordance with Plumbing Code of New York State.

B. Test domestic CPVC water piping system in accordance with Plumbing Code of New York State.

C. Test gas piping system in accordance with Fuel Gas Code of New York State and SED Manual of Planning Standards.

3.8 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe size: 1/2 inches to 1-1/4 inches:
         1) Maximum hanger spacing: 6.5 ft.
         2) Hanger rod diameter: 3/8 inches.
      b. Pipe size: 1-1/2 inches to 2 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 3/8 inch.
      c. Pipe size: 2-1/2 inches to 3 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 1/2 inch.
      d. Pipe size: 4 inches to 6 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 5/8 inch.
   2. Cast Iron (All Sizes) pipe length less than 10':
      a. Maximum hanger Spacing: 5 ft.
      b. Hanger rod diameter: 5/8 inch

3. Cast Iron (All Sizes) with 10 foot length of pipe
   a. Maximum hanger Spacing: 10 ft.
   b. Hanger rod diameter: 5/8 inch
4. CPVC, 1 inch and smaller
   a. Maximum hanger Spacing: 3 ft.
   b. Hanger rod diameter: 1/2 inch
5. CPVC, 1-1/4 inches and larger
   a. Maximum hanger Spacing: 4 ft.
   b. Hanger rod diameter: 1/2 inch

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water closets.

B. Urinals.

C. Lavatories.

D. Sinks.

E. Mop sinks.

F. Drinking Fountain

1.2 RELATED REQUIREMENTS

A. Section 06 41 00 - Architectural Wood Casework: Preparation of counters for sink.

B. Section 07 90 05 - Joint Sealers: Sealing joints between fixtures and walls and floors.

C. Section 22 10 05 - Plumbing Piping And Specialties.

D. Section 22 30 00 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

A. ANSI Z358.1 - American National Standard for Emergency Shower Equipment; 2009.

B. ANSI A117.1 - Accessible and Usable Buildings and Facilities.

C. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008.

D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).

E. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2012.

F. ASME A112.19.2 - Ceramic Plumbing Fixtures; The American Society of Mechanical Engineers; 2013.

G. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use); The American Society of Mechanical Engineers; 2008 (R2013).

H. ASME A112.19.5 - Flush Valves and Spuds for Water-Closet Bowls, Urinals; The American Society of Mechanical Engineers; 2011.

1.4 SUBMITTALS

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

B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

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

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Flush Valve Service Kits: One for each type and size.

1.5 QUALITY ASSURANCE

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

B. Perform Work in accordance with Plumbing Code of New York State.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

A. See Section 01 70 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five-year manufacturer warranty for Plumbing Fixtures.

PART 2 PRODUCTS

2.1 GENERAL

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 MANUFACTURERS:

A. Refer to Plumbing Fixture Schedule on drawing for Manufacturer, Model, Trim and Remarks.

2.3 FLUSH VALVE WATER CLOSETS

A. Water Closet Bowl (WC-1): ASME A112.19.2M; ADA compliant, Wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.6 gallon flush volume.

B. Flush Valve, Electric Powered Sensor Operated (WC-1): ADA compliant, exposed chrome plated diaphragm type with solenoid operator with one wall cover plate. Adaptive infrared sensor and true mechanical over-ride button, 24-hour sentinel flush, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.6 gallon flush volume for use with 1-1/2 inch top spud.
   1. Electrical requirements:
      a. Refer to Plumbing Fixture Schedule on drawing.

C. Seats:
   1. (WC-1): Elongated solid white plastic, open front without cover, self-sustaining hinge, brass bolts.

2.4 WALL HUNG URINALS

A. Urinal, (UR-1) ASME A112.19.2; wall mount, washout, vitreous china urinal with shields. Integrated trap,3/4 inch top spud, steel supporting hanger and 1.0 flush volume.

B. Flush Valve, Electric Powered Sensor Operated (UR-1);Exposed chrome plated,diaphragm type with solenoid operator.

2.5 LAVATORIES

A. Lavatory, Vitreous China Wall Mount Basin (LAV-1): ASME A112.19.2M; ADA compliant, vitreous china wall mount, 20 x 18 inch minimum, with 4 inch high back, 3-hole faucet mount drilling, D-shaped basin with splash lip, front overflow, offset grid drain and pipe covers.

B. Manual Faucet: ASME A112.18.1 (LAV-1): ADA compliant, low lead content, 4 inch on center mount, chrome finish, maximum 0.5 gpm flow of 60 psig, color coded wrist blade handles.

C. Wall Mounted Carrier (LAV-1): ASME A112.6.1; Cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs.

2.6 MOP SINKS

A. Bowl 24 x24 x 10 inch high molded stone, floor mounted with not less that 1 inch wide shoulder, stainless steel cap, stainless steel strainer.

1. Trim: Recessed wall type supply with handles, spout wall brace, vacuum breaker, hose end spout, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
2. Accessories:
   a. Hose clamp hanger.
   b. Mop hanger.

2.8 DRINKING FOUNTAIN

A. Drinking Fountain, bottle filler, Single ADA Cooler Non- Filtered Stainless Steel Hands free, Laminar flow, Furnished with Electronic Bottle Filler Sensor, Electronic Front and side Pushbar

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Confirm that millwork is constructed with adequate provision for the installation of counter top sink.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and bolts.

E. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean plumbing fixtures and equipment.

3.7 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Do not permit use of fixtures by construction personnel.

C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 23 00 20
BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 23.

1.2 SCOPE OF WORK

A. All portions of the work shown in the construction documents shall be bid by the Mechanical Contractor. Responsibility for performance of subcontractors and trades as lower tier contracts, such as electrical, shall be included as part of the Mechanical Contractor's scope of work.

B. Include in bid all labor, materials, tools, plant, transportation, excavation, equipment, insurance, temporary protection, permits, taxes, services and all necessary and related items required to provide complete and operational systems shown and described.

C. References to codes and standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

D. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
   1. Miscellaneous Supports
   2. Access Doors and Panels
   3. Fire Stopping
   4. Cutting and Patching

E. Contract shall include, but not be limited to:
   1. HVAC
   2. General Contracting Work, as related to the HVAC Contract if not shown on architectural plans.

F. Alternates: Provide labor, materials, equipment, and services to perform operations required for the complete installation and related work for the alternate(s) described below and as shown on the Contract Documents. State on the bid form, the amount to be added to or deducted from the base bid if the following alternate(s) is/are accepted:
   1. Refer to project manual for list of alternates.

1.3 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies having jurisdictional authority. In the event of conflict between these contract documents and the governing rules, regulations, and codes, the most stringent standards shall apply as directed by the Engineer and/or Authorities having jurisdiction.

B. Codes and standards that apply to this project include, but are not limited to:
   1. Building Code of New York State.
   2. Energy Conservation Construction Code of New York State. New York State Department of Labor Rules and Regulations.
   3. New York State Department of Health. ASHRAE Standard 62.
   4. National Fuel Gas Code, NFPA 54.

5. Federal Occupational Safety and Health Administration - OSHA. National Life Safety Code, NFPA 101.
6. National Electrical Code, NFPA 70.
7. Local Codes and Ordinances for Rochester, NY; Monroe County NEMA Standards
8. Underwriters Laboratory (UL)
9. Factory Mutual and/or Owner's Insurance Carrier International Standards Organization (ISO)
10. New York Board of Fire Underwriters.
11. Combustion Toxicity Amendment to the New York State Uniform Fire Prevention and Building Code.
12. National Fire Protection Association (NFPA) - All chapters
13.

1.4 LICENSING & PERMITS

A. The Contractor shall hold a license to perform the work as issued by the ruling body of that respective trade.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

1.5 GLOSSARY

ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
EIA	Electronic Industries Association
FCC	Federal Communications Commission
FM	Factory Mutual Insurance Company
IEEE	Institute of Electrical and Electronics

Engineers IRI	Industrial Risk Insurers
ISO	International Standards Organization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
SBI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UL	Underwriter's Laboratories, Inc.

1.6 DEFINITIONS

A. Approved / approval: written permission to use a material or system.

B. As called for: materials, equipment including the execution specified/shown in the contract documents.

C. Code requirements: minimum requirements.

D. Concealed: work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.

E. Design equipment: refer to the article, basis of design. Design make: refer to the article, basis of design.

F. Equal or equivalent: equally acceptable as determined by owner's representative.

G. Exposed: work not identified as concealed.

H. Final acceptance: owner acceptance of the project from contractor upon certification by owner's representative.

I. Furnish: supply and deliver to installation location.

J. Furnished by others: receive delivery at job site or where called for and install.

K. Inspection: visual observations by owner's site representative.

L. Install: mount and connect equipment and associated materials ready for use.

M. Labeled: refers to classification by a standards agency. Make: refer to article, basis of design.

N. Or approved equal: approved equal or equivalent as determined by owner's representative.

O. Owner’s representative: the prime professional.

P. Prime professional: architect or engineer having a contract directly with the owner for professional services.

Q. Provide: furnish, install and connect ready for use.

R. Relocate: disassemble, disconnect, and transport equipment to new

S. Locations, then clean, test, and install ready for use. Replace: remove and provide new item.

T. Review: a general contractual conformance check of specified products. Roughing: pipe, duct, conduit, equipment layout and installation. Satisfactory: as specified in contract documents.

U. Site representative: construction manager or owner's inspector at the work site.

V. Refer to general conditions of the contract for additional definitions.

1.7 BASIS OF DESIGN

A. The contract documents are prepared on the basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in work of all other trades, at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assumes responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings or floors required to install other than design make equipment. Contractor shall retain the ultimate responsibility for function of equipment and materials which are not the basis of design for the contract documents. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.8 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

B. In the event of conflict between the drawings and specifications, or discrepancies within either, this shall be brought to the attention of the Engineer for resolution prior to submission of bids. In the event that the contractor fails to note these discrepancies prior to submission of bids or in writing within their bid submission, the Engineer shall resolve the discrepancy such that the design intent is provided. The contractor shall provide all labor, materials and equipment to correct the installation deficiencies as defined by the Engineer.

1.9 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with Cad files for this project with the understanding that these Cad files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors’ responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors’ coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors’ failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

1.10 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size/capacity of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction or details of workmanship, not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and construction indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide Materials That Meet the Following Minimum Requirements:
   1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.
   2. All equipment and material for which there is a listing service shall bear a UL label.
   3. Potable water systems and equipment shall be built according to AWWA Standards.
   4. Gas-fired equipment and systems shall meet AGA Regulations and shall have an AGA label.
   5. Electrical equipment and systems shall meet UL Standards and requirements of the
      a. N.E.C. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with UL Standards and the requirements of the N.E.C.
         1) Communications equipment shall meet all FCC Regulations
         2) All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
         3) 8 The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

2.2 SUBSTITUTIONS

A. The materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material, product or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties and location of three(3) similar installations with reference names of owner or facility personnel responsible for maintaining equipment. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders. Failure to follow the guidelines described above may result in equipment being rejected at submittal based solely on failure to follow the above guidelines.

C. Approval by the Architect and/or Engineer to proceed with a substitution does not relieve the contractor from meeting all of the dimensional requirements and maintaining the full functionality and performance of the material, product or equipment used as the basis of design. See Section 3.19 for engineering related to substitute equipment and/or materials.

D. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

2.3 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.
   1. All components of an assembled unit need not be products of the same manufacturer.
   2. Constituent parts which are alike shall be products of a single manufacturer.
   3. Components shall be compatible with each other and with the total assembly for intended service.
   4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear the manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 SPECIAL TOOLS

A. If any part of equipment requires a special tool for assembly, adjustment or maintenance thereof and such tool is not readily available in the commercial tool market, it shall be furnished by the Contractor as required for the duration of the project and turned over to the Owner in serviceable condition upon completion of the scope of work. Contractor shall obtain written sign off by the Owner certifying that the Owner is in receipt of such tools.

2.6 SAFETY GUARDS

A. Provide guards on all shafts and couplings and all V-belt and sheave assemblies to prevent damage to equipment and injury to personnel.

2.7 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

2.8 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:
   1. Steel plates, shapes, bars, and grating - ASTM A 36
   2. Cold-Formed Steel Tubing - ASTM A 500
   3. Hot - Rolled Steel Tubing - ASTM A 501
   4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal fasteners shall be zinc-coated (type, grade and class as required).

2.9 ACCESS DOORS AND PANELS

A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Provide access doors at all locations where equipment access for service, repair, and/or adjustment may be required. This shall include access to all air balance dampers. (In lieu of access to air balance dampers above hard ceilings or in chase walls, Contractor may submit for approval for use of remote regulators.)

C. Construction:
   1. Frames:
      a. 16 gage steel with 1 inch wide, exposed, perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast-in-place concrete, or ceramic tile.
      b. 16 gage steel, perforated flanges with bead for gypsum or plaster wall board.
      c. 16 gage steel with galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.
         1) Access Doors:
            (a) Provide 14 gage sheet steel, flush panel doors with concealed, continuous, factory-installed piano hinge, primed and painted, set to open 175 degrees in unrated partitions.
            (b) Provide fire-rated, insulated, flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1-½ hour “B” labeled, in fire-rated partitions.
         2) Provide flush, screwdriver operated cam locks on all access doors.

2.10 FIRE STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated by ASTM E814.

B. Acceptable Manufacturers:
   1. Dow Corning Fire-Stop System Foams and Sealants.
   2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
   3. Thomas & Betts - S-100 FS500/600,

4. Carborundum Fyre Putty.

PART 3 - EXECUTION

3.1 SUBMITTALS: SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Incomplete submittals will not be accepted. Number each submittal. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve the Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

B. Approval of shop drawings will not relieve this contractor from responsibility for errors and omissions therein. All such errors or omissions must be corrected by this contractor irrespective of any approvals by the Architect or Engineer.

C. Pre-test submittals must be written in report format, submitted and signed off on by Owner and Engineer prior to the start of any construction work, including demolition.

D. Shop drawings include, but are not limited to, the submissions listed below. Refer to individual specification sections for specific requirements and additional submission requirements.

3.2 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature(s) required to provide safe conditions for all workmen and site visitors.

3.3 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work, inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented and submitted, the Contractor shall repair all damage found at the completion of the project that is determined to have been caused by the work of this contract. Repairs shall restore the area to like new condition.

B. The Owner’s Representative shall determine if the Contractor has damaged existing systems or construction and shall approve the repairs.

3.4 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The Contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the Owner’s asbestos management plan. Prior to performing such work, identify areas containing asbestos. Notify the Owner so that arrangements may be made for abatement and/or containment prior to work proceeding. The Contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 Sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to Division 2 sections for further requirements.

3.5 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that the Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by the Owner. Items that the Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, each crawl space and each roof to determine total Scope of Work. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

3.6 STORAGE AND PROTECTION OF MATERIALS

A. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

B. Refer to "General Conditions of the Contract for Construction."

3.7 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building. Perform first seasons winterizing in presence of Owner's operating staff.

3.8 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. DO NOT SCALE PLANS. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner’s Representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.
   1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.
   2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owner's Representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the Contractor at no expense to the Owner.
   3. For equipment and connections provided in this contract, prepare roughing drawings as follows:
      a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for
      b. installation in new location.
      c. b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in
         1) drawings.
         2) Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

D. All equipment requiring service and / or access shall be provided adequate clearances for this purpose. Any clearances described in manufacturer's information, code requirements, etc., shall be taken into account in determining final rough-in positions. Reasonable access for maintenance and service shall be maintained. The most stringent standard, as determined by the Engineer, shall apply.

3.9 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.10 CONCEALMENT

A. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.11 ACCESS DOORS AND PANELS

A. Provide access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.

B. Provide access doors, sized to permit compete access for all items requiring adjustment, such as balance dampers above solid ceilings.

C. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Access doors and panels shall operate freely and be fully usable for their intended function.

3.12 CHASES

A. New Construction:
   1. Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical and Electrical Trades work shall provide all other openings required for their contract work.
   2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.
   3. Assume responsibility for correct and final location and size of such openings.
   4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
   5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2" above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.
   6. Provide angle iron frame where openings are required for contract work, unless provided by General Construction Contractor.

B. In Existing Buildings:
   1. Drill holes for floor and/or roof slab openings.
   2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.

3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors.
4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

3.13 FIRE-STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:
1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.
2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire-rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.
3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
4. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.
6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.14 FLASHING AND SEALING

A. Openings through roofs shall be flashed in a manner to not affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of the contract. Provide non-ferrous flashing pieces, skirts, hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Where openings for pipe/duct penetrate through roofs into equipment pipe chases, mechanical spaces or penthouses, the penetration of the roof deck/slab shall be sleeved, sealed and firestopped as required. Insulate at base of pipe chase, mechanical space or penthouse to match insulation value of the roofing system.

C. Apply all flashing and sealers within the temperature and humidity limits permitted by the manufacturer.

3.15 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support mechanical/electrical work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

3.16 GENERAL INSTALLATIONS REQUIREMENTS

A. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed

B. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

C. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

D. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

E. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

F. No equipment shall be hidden or covered up prior to inspection by the Owner’s Representative. All work requiring inspection which is concealed prior to approval shall be re-opened for inspection at the Contractor’s expense. All work that is determined to be unsatisfactory shall be corrected immediately.

G. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

H. Install access panels or doors where units are concealed behind finished surfaces.

3.17 PAINTING

A. This Contract Includes the following:
   1. Painting for all cut and patch work performed as part of Division 23 contract.
   2. Painting required for touch-up of surfaces damaged due to the installation of Division 23 work.
   3. Painting as required to repair finish of equipment furnished.
   4. Refer to Section 09 90 00-Painting, for general description of materials and methods
   5. Painting as called for on Division 23 Drawings and/or Specifications.

3.18 ADDITIONAL ENGINEERING SERVICES

A. In the event the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

B. In the event the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

C. In the event the Consultant is required to initiate design changes due to failure of the contractor to properly coordinate with the construction schedule, and / or other trades, then the Consultant’s hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owned to the Contractor.

3.19 ALL TRADES TEMPORARY HEAT

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

3.20 HVAC MAINTENANCE OF SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of pre-filters in addition to the permanent filters. Furnish four sets of pre-filters for each system for use when system is operated for temporary heating or cooling. During such use, change pre-filters as often as directed by Owner's Representative. Provide necessary temporary throwaway filters in all return openings to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply units only. Do not operate return fans.

B. Blank-off outside air intake opening during construction. Install first set of permanent filters and pre-filters. Install filters over all return air openings with adequate efficiency and capacity to keep construction dust and debris out of the duct systems. Contamination of the duct systems shall necessitate cleaning to dust free condition.

C. Adjust dampers on supply system.

D. Set all heating coil control valves for manual operation.

E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.

F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilation.

G. Repair or replace all dented, scratched or damaged parts of systems.

H. Remove concrete, rust, paint spots, other blemishes, then clean.

I. Just prior to final acceptance, remove used final filter. Deliver all unused sets of pre-filters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, fire stats, overload devices, and all other safety controls in operating condition.

3.21 TEMPORARY FACILITIES

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.
   1. Continuity of operation of existing facilities will require temporary installation or relocation of equipment and piping.
   2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
   3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining pressurized.

3.22 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

B. Cleanliness of construction shall extend to include the interior and exterior surfaces of all equipment and systems provided under this contract. This includes, but is not limited to:
   1. Unitary equipment exposed to occupant use (cabinet heaters, baseboard systems, etc.) Shall be thoroughly cleaned for final use both inside and out prior to project completion.
   2. Equipment located in mechanical spaces shall be cleaned on the exterior such that no significant accumulation of debris or dirt is evident.
   3. Interiors of all air handling equipment (rooftop systems, air handlers, etc.) shall be thoroughly cleaned on the interior such that no evidence of dust, dirt or debris remains prior to project turnover.
   4. Ductwork systems – Ductwork shall be delivered to the job site with ends capped or covered to eliminate contamination during transportation and site storage. All open ends shall remain covered during the entire course of the construction process. Ductwork with evidence of dust, dirt or debris shall be thoroughly cleaned by an approved method prior project turnover.

3.23 HVAC EQUIPMENT CONNECTIONS

A. Provide final steam, condensate, hot water, glycol, chilled and condenser water, drain, vent, oil line and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.

B. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.

C. Refer to manufacturer’s drawings and specifications for requirements of medical equipment, laboratory equipment and special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.24 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical facilities or services.

3.25 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner’s designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed. Prior to acceptance repeat the instructions. if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e. variable frequency drive and air handling unit) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up, including problems that occurred and their method of resolution.

3.26 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of: approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier, manufacturer’s representative and service agency for all major equipment items. Bind above items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance.

3.27 RECORD DOCUMENTS

A. In addition to all requirements elsewhere in the Contract Documents, prepare and provide record documents of the as-constructed work which meets the following minimum standards:
   1. Utilities below floors, slabs and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.
   2. Take dimensions from a given fixed bench mark, such as the corner of a building, and neatly and clearly indicate same on reproducible prints.
   3. Provide Record Drawings for all Contract Work. Document the location of control devices isolation valves, safety devices and equipment.
   4. Submit reproducible tracings, with all required corrections and submit complete set of final approved record drawings in PDF file format on CD.
   5. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

3.28 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

B. HVAC items normally accepted as salvage by the Owner:
1. Window air-conditioning units
2. Pumps
3. High efficiency motors above ½ HP
4. Temperature control and automation hardware
5. Unit Ventilator coils and motors.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Pipe, duct, and equipment hangers, supports, and associated anchors.

B. Flashing and sealing equipment.

1.2 QUALITY ASSURANCE

A. Fabrication and Installation Practices for Duct Hangers and Supports: In conformance with SMACNA - Low Pressure Duct Construction Standards, 5th Edition.

B. Fabrication and Installation Practices for Pipe Hangers and Supports: In conformance with MSS SP-89.

1.3 SUBMITTALS

A. Refer to Specification Section 230512 for all requirements.

1.4 ACCEPTABLE MANUFACTURERS

A. Subject to compliance, manufacturers offering products for the work include, but is not limited to, the following:
1. Britt Engineering.
2. Pate.
3. RPS Corporation.
4. Cooper Industries.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes ½" to 1½": Carbon steel, adjustable swivel, split ring; MSS Type 10.

B. Hangers for Pipe Sizes 2" to 4" and Cold Pipe Sizes 6" and Over: Carbon steel, adjustable, clevis, MSS type 1.

C. Hangars for Hot Pipe Sizes 6" and Over: Adjustable steel yoke, cast iron roll, double hanger; MSS Type 43.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 6" and over; MSS Type 41.

E. Wall Support for Pipe Sizes to 3": Cast iron hook.

F. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 6" and over.

G. Vertical Support: Steel riser clamp; MSS Type 42.

H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated; MSS Type 10.

I. Shield for Insulated Piping 2" and Smaller: 18 gage galvanized steel shield over insulation in 180 segments, minimum 12" long at pipe support; MSS Type 40.

J. Shield for Insulated Piping 2½" and Larger (Except Cold Water Piping): Pipe covering protective saddles; MSS Type 39.

K. Shields for Insulated Cold Water Piping 2½" and Larger: 12" minimum length; MSS Type 40.

L. Shields for Vertical Copper Pipe Risers: Sheet lead.

M. Wall Mounted Support Bracket: Factory fabricated and primed; all steel, welded construction, in compliance with ANSI/MSS SP-58. Maximum support loading as listed below:

MSS SP-69 TYPE 31	750	lb. MAX LOAD
MSS SP-69 TYPE 32	1,500	lb. MAX LOAD
MSS SP-69 TYPE 33	3,000	lb. MAX LOAD

2.2 DUCT HANGERS AND SUPPORTS

A. Fabricate round and rectangular duct hangers and supports from materials and methods outlined in SMACNA - Low Pressure Duct Construction Standards, 5th Edition.

2.3 HANGER RODS

A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.4 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Flexible Flashing: 47 mil thick sheet compatible with roofing.

C. Caps: Steel, 22 gage minimum, 16 gage at fire-resistant elements.

2.6 FABRICATION

A. Design hangers without disengagement of supported pipe.

B. Provide copper plated hangers and supports for copper piping.

2.7 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl space, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".

D. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

F. Refer to Division 1 for coordination requirements.

3.2 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as follows:

PIPE SIZE	MAX. HANGER SPACING	HANGER ROD DIAMETER
½" to 1 ½"	6'-0"	3/8"
2"	10'-0"	3/8"
2 ½" to 3"	10'-0"	½"
PVC (All sizes)	6'-0"	3/8"

B. Install hangers to provide minimum ½" space between finished covering and adjacent work.

C. Place a hanger within 12" of each horizontal elbow.

D. Use hangers with 1½" minimum vertical adjustment.

E. Support vertical piping at every floor.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Support riser piping independently of connected horizontal piping.

3.3 DUCT HANGERS AND SUPPORTS

A. Support all round and rectangular ductwork with methods and support spacing as specified in SMACNA - Low Pressure Duct Construction Standards, 5th Edition.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.4 SUBMITTALS

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

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

F. Project Record Documents: Record actual locations of tagged valves.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.6 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Air Terminal Units: Tags.

C. Automatic Controls: Tags. Key to control schematic.

D. Control Panels: Nameplates.

E. Dampers: Ceiling tacks, where located above lay-in ceiling.

F. Ductwork: Stenciled painting.

G. Major Control Components: Nameplates.

H. Piping: Pipe markers.

I. Pumps: Nameplates.

J. Small-sized Equipment: Tags.

K. Tanks: Nameplates.

L. Thermostats: Nameplates.

M. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2 NAMEPLATES

A. Manufacturers:
   1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
   2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
   3. Substitutions: See Section 01 60 00 - Product Requirements.
   4. Letter Color: White.
   5. Letter Height: 1/2 inch.
   6. Background Color: Red.

2.3 TAGS

A. Manufacturers:
   1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
   2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

D. Valve Tag Chart: Typewritten letter size list of applied tags and locations in plastic laminated frame.

2.4 STENCILS

A. Manufacturers:
1. Brady Corporation: www.bradycorp.com.
2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
6. Ductwork and Equipment: 2-1/2 inch high letters.

C. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.5 PIPE MARKERS

A. Manufacturers:
1. Brady Corporation: www.bradycorp.com.
2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Color and Lettering: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Color code as follows:
1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
2. Toxic and Corrosive Fluids: Orange with black letters.
3. Compressed Air: Blue with white letters.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with manufactures installation instructions.

D. Apply stencil painting in accordance with Section 09 90 00.

E. Install plastic pipe markers in accordance with manufacturer's instructions.

F. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

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

PART 1 GENERAL

1.1 SECTION INCLUDES

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

B. Measurement of final operating condition of HVAC systems.

C. Commissioning activities.

1.2 RELATED REQUIREMENTS

A. Section 01 40 00 - Quality Requirements: Employment of testing agency and payment for services.

1.3 REFERENCE STANDARDS

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2008.

C. NEBB (TAB) - Procedural Standard for Testing Adjusting and Balancing of Environmental Systems; National Environmental Balancing Bureau; 2005, Seventh Edition.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.4 SUBMITTALS

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

B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval.

C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the project engineer/Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   6. .

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

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air flow measuring points balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Prior to commencing Work, calibrate each instrument to be used.

1.7 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC or Certified by NEBB.

1.8 SEQUENCING

A. Section 01 10 00 - Summary: Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
1. AABC MN-1, AABC National Standards for Total System Balance.
2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
4. SMACNA (TAB).

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

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

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

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

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.

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

3.3 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect and project engineer / Commissioning Authority to facilitate spot checks during testing.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

3.5 RECORDING AND ADJUSTING

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

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

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

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

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

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

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.7 SCOPE

A. Test, adjust, and balance the following:
   1. Furnace F-1 and associated air inlets and outlets.
   2. Air Handlers, AH-1, AH-2

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.

B. Duct Liner.

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 09 91 23 - Interior Painting: Painting insulation jackets.

C. Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.3 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.

B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.

D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

F. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

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

1.4 SUBMITTALS

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

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

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

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

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturer:
1. Knauf Insulation; www.knaufinsulation.com.
2. Owens Corning Corporation; www.ocbuildingspec.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

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

2.3 DUCT LINER

A. Manufacturers:
1. Knauf Insulation; www.knaufinsulation.com.
2. Owens Corning Corp: www.owenscorning.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: Incombustible glass fiber complying with ASTM C 1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer or acrylic polymer shown to be fungus and bacteria resistant by testing to ASTM G 21.
1. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
2. Service Temperature: Up to 250 degrees F.
3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
4. Minimum Noise Reduction Coefficients:
   a. 1 inch Thickness: 0.45.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

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

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated ducts conveying air below ambient temperature:

C. Insulated ducts conveying air above ambient temperature:

D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

E. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with calked aluminum jacket with seams located on bottom side of horizontal duct section.

F. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

A. Exhaust Ducts Within 10 ft of Exterior Openings: 1" ridged liner

B. Outside Air Intake Ducts: 2" flexible for concealed above ceilings, 2" ridged board for exposed in unconditioned spaces.

C. Supply, Return & transfer Ducts: 2" flexible for concealed above ceilings

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 07 84 00 - Firestopping.

C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

D. Section 23 22 13 - Steam and Condensate Heating Piping: Placement of hangers and hanger inserts.

E. Section 23 23 00 - Refrigerant Piping.

1.3 REFERENCE STANDARDS

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.

C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2013.

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.

F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2015.

G. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

I. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

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

1.4 SUBMITTALS

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

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

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

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

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

PART 2 PRODUCTS

2.1 REGULATORY **REQUIREMENTS**

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

2.2 GLASS FIBER

A. Manufacturers:
1. Knauf Insulation: www.knaufinsulation.com.
2. Owens Corning Corp: www.owenscorning.com.

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

C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum Service Temperature: 650 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

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

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.3 CELLULAR GLASS

A. Insulation: ASTM C552, Type II.
1. Apparent Thermal Conductivity; 'K' Value: Grade 6, 0.35 at 100 degrees F.
2. Service Temperature: Up to 800 degrees F.

3. Water Absorption: 0.5 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
1. Armacell LLC; : www.armacell.us.

2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.
1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

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

2.5 JACKETS

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

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
1. Thickness: 0.016 inch sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

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

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

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

D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature.
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

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

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

3.3 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return: Glass Fiber Insulation; pipe size up to 2" = 1 1/2" thick; pipe size 2" to 6" = 2" thick.

B. Cooling Systems:
   1. Condensate Drains from Cooling Coils: Flexible Elastomeric Cellular Insulation; All pipe sizes = 1 1/2" thick.
   2. Refrigerant Suction: Flexible Elastomeric Cellular Insulation; All pipe sizes = 1 1/2" thick.

END OF SECTION

SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Concrete bases.

1.3 DEFINITIONS

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

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

1.5 ACTION SUBMITTALS

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

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.

B. Shop Drawings: For facility Propane-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.
   1. Shop Drawing Scale: 1/4 inch per foot.
   2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

1.6 CLOSEOUT SUBMITTALS

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

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility- locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

   1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

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

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. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   3. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   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.

2.2 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.3 MANUAL GAS SHUTOFF VALVES

A. 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.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. 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.

2.4 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for Propane gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

2.5 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 EXAMINATION

A. Examine roughing-in for Propane-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off Propane gas to premises or piping section.

B. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. 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.

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of Propane-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 piping free of sags and bends.

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

J. Verify final equipment locations for roughing-in.

K. 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.

L. 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.

M. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

N. Connect branch piping from top or side of horizontal piping.

O. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

P. Do not use gas piping as grounding electrode.

Q. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

R. Install pressure gage downstream from each line regulator.

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

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.5 VALVE INSTALLATION

A. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

B. Install anode for metallic valves in underground PE piping.

3.6 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. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

E. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

B. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. 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.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 PAINTING

A. Comply with requirements for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
1. Alkyd System: MPI EXT 5.1D.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
   c. Topcoat: Exterior alkyd enamel (flat).
   d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Interior latex matching topcoat.
   c. Topcoat: Interior latex (eggshell).
   d. Color: Yellow.
2. Alkyd System: MPI INT 5.1E.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Interior alkyd matching topcoat.
   c. Topcoat: Interior alkyd (eggshell).
   d. Color: Yellow.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Propane-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves in branch piping for single appliance shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Moisture and liquid indicators.

C. Valves.

D. Strainers.

E. Check valves.

F. Filter-driers.

G. Solenoid valves.

H. Expansion valves.

I. Receivers.

1.2 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.

B. Section 23 07 19 - HVAC Piping Insulation.

C. Section 23 74 13 - Packaged Outdoor AHU.

D. Section 23 81 27 - Small Split Heating & Cooling Units.

1.3 REFERENCE STANDARDS

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; Air-Conditioning, Heating, and Refrigeration Institute; 2005.

B. AHRI 710 - Performance Rating of Liquid-Line Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2009.

C. AHRI 730 - Flow Capacity Rating and Application of Suction-Line Filters and Suction-Line Filter- Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2005.

D. AHRI 750 - Standard for Thermostatic Refrigerant Expansion Valves; Air-Conditioning, Heating, and Refrigeration Institute; 2007.

E. AHRI 760 - Standard for Performance Rating of Solenoid Valves for Use With Volatile Refrigerants; Air-Conditioning, Heating, and Refrigeration Institute; 2007.

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013 (ANSI/ASHRAE Std 15).

G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2013.

H. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2015.

I. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.

J. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes; The American Society of Mechanical Engineers; 2013.

K. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2013.

L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.

M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.

N. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.

O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011-AMD 1.

P. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

Q. UL 429 - Electrically Operated Valves; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

C. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

D. Receivers:
   1. Use on systems 5 tons and larger, sized to accommodate pump down charge.
   2. Use on systems with long piping runs exceeding 100 feet.

1.5 SUBMITTALS

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

B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of leak test, acid test.

F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

G. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

C. Welders Certification: In accordance with ASME BPVC-IX.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for valves excluding packing.

1.13 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.14 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.1 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
   1. Fittings: ASME B16.26 cast copper.
   2. Joints: Flared.

C. Pipe Supports and Anchors:
   1. Conform to ASME B31.5.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
   3. Vertical Support: Steel riser clamp.
   4. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   5. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.2 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.3 VALVES

A. Diaphragm Packless Valves:
   1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

B. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.4 STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.5 CHECK VALVES

A. Globe Type:

1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 500 psi.

B. Straight Through Type:
   1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 250 degrees F.

2.6 PRESSURE RELIEF VALVES

A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 450 psi.

2.7 FILTER-DRIERS

A. Performance:
   1. Design Working Pressure: 500 psi, minimum.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.
   1. Connections: As specified for applicable pipe type.

2.8 SOLENOID VALVES

A. Valve: AHRI 760, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

2.9 EXPANSION VALVES

A. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.10 RECEIVERS

A. Internal Diameter 6 inch and Smaller:
   1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

B. Internal Diameter Over 6 inch:
   1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

PART 3 EXECUTION

3.1 PREPARATION

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

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

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

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

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

E. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.5.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.

F. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

G. Provide clearance for installation of insulation and access to valves and fittings.

H. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 31 00.

I. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

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

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.4 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

SECTION 23 31 00

HVAC DUCTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Nonmetal ductwork.

C. Duct cleaning.

1.2 RELATED REQUIREMENTS

A. Section 09 90 00 - Exterior Painting: Weld priming, weather resistant, paint or coating.

B. Section 23 07 13 - Duct Insulation: External insulation and duct liner.

1.3 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

D. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2015.

E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

H. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.

I. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.

J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.

K. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2015.

M. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; National Fire Protection Association; 2015.

N. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

O. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.

P. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

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

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all modifications/systems.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements 01 70 00 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A standards.

1.8 QUALITY ASSURANCE

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

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

1.9 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.10 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.11 FIELD MEASUREMENTS

A. Verify field measurements of all duct installations prior to fabrication.

1.12 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements, Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.

B. Ducts: Galvanized steel, unless otherwise indicated.

2.2 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.

C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. VOC Content: Not more than 250 g/L, excluding water.
   3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
   4. For Use With Flexible Ducts: UL labeled.

D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
   2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
   3. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
   4. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

F. Insulated Flexible Ducts:
   1. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
      a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
      b. Maximum Velocity: 4000 fpm.
      c. Temperature Range: -10 degrees F to 160 degrees F.

2.3 MANUFACTURED DUCTWORK AND FITTINGS

A. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
   1. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.
   2. Maximum Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 degrees F to 175 degrees F.

2.4 INSULATED FLEXIBLE DUCTS

A. Product Description: Black polymer film supported by helical-wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.
   1. Pressure Rating: 4 inches wg positive and 0.5 inches wg negative.
      a. Maximum Velocity: 4000 fpm.
      b. Temperature Range: -20 degrees F to 175 degrees F.
      c. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.5 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:
   1. McGill AirFlow Corporation.
      a. Semco Incorporated.
      b. Tangent Air Corp.
      c. Spiral Mfg. Co., Inc.

B. Product Description: UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.

C. Construct duct with the following minimum gages:

	Diameter	Gauge
1.	3 inches to 14 inches	26
2.	15 inches to 26 inches	24
3.	28 inches to 36 inches	22
4.	38 inches to 50 inches	20
5.	52 inches to 84 inches	18

D. Construct fittings with the following minimum gages:

	Diameter	Gauge
1.	3 inches to 14 inches	24
2.	15 inches to 26 inches	22
3.	28 inches to 36 inches	20
4.	38 inches to 50 inches	20
5.	52 inches to 60 inches	18
6.	62 inches to 84 inches	16

2.6 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

D. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

G. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

H. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

E. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. Use double nuts and lock washers on threaded rod supports.

H. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

I. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

J. Connect flexible ducts to metal ducts with adhesive.

K. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

L. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

M. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.2 CLEANING

A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.3 SCHEDULES

A. Ductwork Material:
   1. Low Pressure Supply (Heating Systems): Steel, Aluminum.
   2. Return and Relief: Galvanized Steel.
   3. General Exhaust: Galvanized Steel.
   4. Outside Air Intake: Galvanized Steel.

B. Ductwork Pressure Class:
   1. Supply (Heating Systems): 1 inch
   2. Return and Relief: 1 inch.
   3. General Exhaust: 1 inch.
   4. Outside Air Intake: 1 inch.

END OF SECTION

SPECIFICATION 23 34 00
HVAC FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. In-line direct drive exhaust fans.

B. B. Ceiling exhaust fans

C. Accessories.

1.2 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210.

B. Sound Ratings: AMCA 301, tested to AMCA 300.

C. Fabrication: Conform to AMCA 99.

1.3 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Provide fan curves with specified operating point clearly plotted.

C. Submit sound power levels for both fan inlet and outlet at rated capacity.

D. Submit manufacturer's installation instructions under provisions of Division 1.

1.4 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products for the work include, but are not limited to the following:
   1. Design Basis: Twin City
   2. Greenheck
   3. Cook.
   4. Penn-Barry.

PART 2 - PRODUCTS

A. ACCESSORIES
   1. Wall Caps: Aluminum construction; integral back draft damper; bird screen for rectangular style.
   2. Weather hood: Aluminum construction with galvanized steel internal supports; integral bird screen.
   3. Speed Controller: Solid state; range up to 10 amps.
   4. Automatic Louver: Electrically actuated louver.

2.2 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount electronic variable speed control inside fan cabinet or adjacent to fan unless noted otherwise; coordinate installation of speed controller with EC.

C. Automatic Damper Control:
1. Constant Volume Fans - Contractor is to provide and install a control relay for 115 volt-1 phase damper actuator control and required actuator control wiring (115 volt-1 phase) at fan, for fans requiring automatic dampers (refer to fan schedule). Power can be taken from main power to fan motor starter. Coordinate with Division 16 contractor and sequence of operations.

D. Refer to Division 1 for coordination requirements.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.2 RELATED REQUIREMENTS

A. Section 09 90 00 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.3 REFERENCE STANDARDS

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.

B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006 (R2011).

1.4 SUBMITTALS

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

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Project Record Documents: Record actual locations of air outlets and inlets.

D. Test Reports: Rating of air outlet and inlet performance.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

B. Test and rate louver performance in accordance with AMCA 500-L.

1.6 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products include, but are not limited to the following:
   1. Titus.
   2. Krueger.
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 DRUM DIFFUSERS S-1

A. Type: Model DL Drum Louver, Extruded Aluminum

B. Frame: Factory fabricated welded frame

C. Fabrication: Aluminum with mill finish.
Accessories: Opposed blade volume damper.

2.3 WALL SUPPLY REGISTERS/GRILLES R-1

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with double deflection.

B. Frame: 11/4 inch margin with countersunk screw mounting and gasket.

C. Fabrication: Steel, #26 White Finish

D. Damper: None

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.

END OF SECTION

SECTION 23 81 27
SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air-source heat pumps.

B. Air cooled condensing units.

C. Indoor ductless fan & coil units.

D. Controls.

1.2 RELATED REQUIREMENTS

A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

B. AHRI 270 - Standard for Sound Performance Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2015.

C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.

D. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2015.

F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; National Fire Protection Association; 2015.

G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

D. Design Data: Indicate refrigerant pipe sizing.

E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the work of this section.

1.6 WARRANTY

A. See Section 01 70 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.
   2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

2.2 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
   1. Location: High-wall.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
   2. Manufacturer: System manufacturer.

2.3 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Comply with AHRI 210/240.
   2. Refrigerant: R-410A.
   3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion valves.

D. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.

B. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION

Variable Refrigerant Flow Systems

Section 23 81 28

PART 1 General

1.1 SYSTEM DESCRIPTION Y-SERIES (HEAT/COOL MODEL) Per the equipment schedule, the variable capacity, heat pump air conditioning system basis of design is Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system(s).

A. Acceptable alternative manufacturers, assuming compliance with these equipment specifications, are Daikin, Panasonic, and Hitachi. Contractor bidding an alternate manufacturer does so with full knowledge that that manufactures product may not be acceptable or approved and that contractor is responsible for all specified items and intents of this document without further compensation.

1.2 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

B. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

C. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

D. System start-up supervision shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in system configuration and operation. The representative shall provide proof of manufacturer certification indicating successful completion within no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendation.

1.4 WARRANTY

A. The CITY MULTI units shall be covered by the manufacturer’s limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.

B. Installing contractor shall meet manufacturer requirements to obtain extended manufacturer’s limited parts and compressor warranty for a period of ten (10) years to the original owner from date of installation. This warranty shall not include labor.

C. Manufacturer shall have a minimum of fifteen (15) years continuous experience providing VRF systems in the U.S. market.

D. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

E. The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

PART 2 OUTDOOR UNITS'

2.1 Y-SERIES HIGH EFFICIENCY (HEAT PUMP), AIR-COOLED OUTDOOR UNITS

A. General: The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Part 5 (Controls). The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

1. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
2. Outdoor unit shall have a sound rating no higher than 68 dB(A) individually or 69.5 dB(A) twinned. Units shall have a sound rating no higher than 55 dB(A) individually or 55.5 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
3. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
4. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.
5. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
6. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
7. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
8. The outdoor unit shall be capable of guaranteed operation in heating mode down to -25F ambient temperatures and cooling mode up to 126°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.
9. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
10. Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.

11. While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature, systems that keep fan running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.
12. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.

B. Unit Cabinet:

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
2. The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.
3. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised, and the panel should be replaced immediately.

C. Fan:

1. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.
2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fans shall be provided with a raised guard to prevent contact with moving parts.

D. Refrigerant and Refrigerant Piping

1. R410A refrigerant shall be required for systems.
2. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
3. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.
4. All refrigerant piping must be insulated with ½” closed cell, CFC-free foam insulation with flame- Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
5. Refrigerant line sizing shall be in accordance with manufacturer specifications.

E. Coil:

1. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.
2. Outdoor Coil shall be elevated at least 12” from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer’s in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12” of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.
3. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.
4. The coil shall be protected with an integral metal guard.

5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
6. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.
7. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

F. Compressor:

1. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
2. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.
3. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.
4. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.
5. The compressor shall be equipped with an internal thermal overload.
6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
7. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

G. Controls:

1. The unit shall be an integral part of the system & control network described in Part 5 (Controls) and react to heating/cooling demand as communicated from connected indoor e control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.
2. The outdoor unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.

H. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz per equipment schedule.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

PART 3 INDOOR UNITS

3.1 4-WAY CEILING-RECESSED CASSETTE WITH GRILLE FOR 2X2 GRID INDOOR UNIT

A. General:

1. The indoor unit shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch.
2. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Unit Cabinet:

1. The cabinet shall be a compact 22-7/16" wide x 22-7/16" deep so it will fit within a standard 24" square suspended ceiling grid.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.

C. Fan:

1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall be capable of three (3) speed settings, Low, Mid, and High.
4. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
5. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
6. Grille shall include an optional "3D i-see" sensor, or equal, to work in conjunction with indoor unit control sequence to prevent unnecessary cooling or heating in unoccupied areas of the zone without decreasing comfort levels. Sensor must detect occupancy (not simply motion) and location of occupants by measuring size & temperature of objects within a 39' detecting diameter (based on 8.8ft mounting height) with 1,856 or more measuring points.

D. Filter:

1. Return air shall be filtered by means of a long-life washable filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
4. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
5. A factory-installed drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur, the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

3.2 1-WAY CEILING-RECESSED CASSETTE WITH GRILLE INDOOR UNIT

A. General:

1. The one-way cassette indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Unit Cabinet:

1. The cabinet panel shall have provisions for a field installed filtered outside air intake. Branch ducting shall be allowed from cabinet.
2. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.

C. Fan:

1. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor with permanently lubricated bearings.
2. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.

D. Filter:

1. Return air shall be filtered by means of a long-life washable permanent filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
4. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
5. A factory-installed drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

3.3 HIGH STATIC, CEILING-CONCEALED DUCTED INDOOR UNIT

A. General:

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Unit Cabinet:

1. The cabinet shall be ceiling-concealed, ducted with a fixed rear return and a horizontal discharge supply.

2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

C. Fan:

1. Indoor unit shall feature adjustable external static pressure settings up to 1.00 in. WG.

2. The indoor unit fan shall be an assembly with one or two statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.

D. Filter:

1. Return air shall be filtered by a field-supplied filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.

2. The coils shall be pressure tested at the factory.

3. Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

H. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
1. Control board shall include contacts for control of no less than two stages of external heat. The first stage of external heat may be energized when the space temperature is 2.7°F from set point for between 10-25 minutes (user adjustable). The second stage of external heat may be energized when the first stage has been active for no less than 5 minutes and the space temperature has not risen by more than 0.9°F.
2. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
3. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

PART 4 Controls

4.1 OVERVIEW

A. The control system shall consist of a low voltage communication network and a web-based interface. The controls system shall gather data and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
B. Furnish energy conservation features such as optimal start, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
C. System shall be capable of email generation for remote alarm annunciation.

4.2 ELECTRICAL CHARACTERISTICS

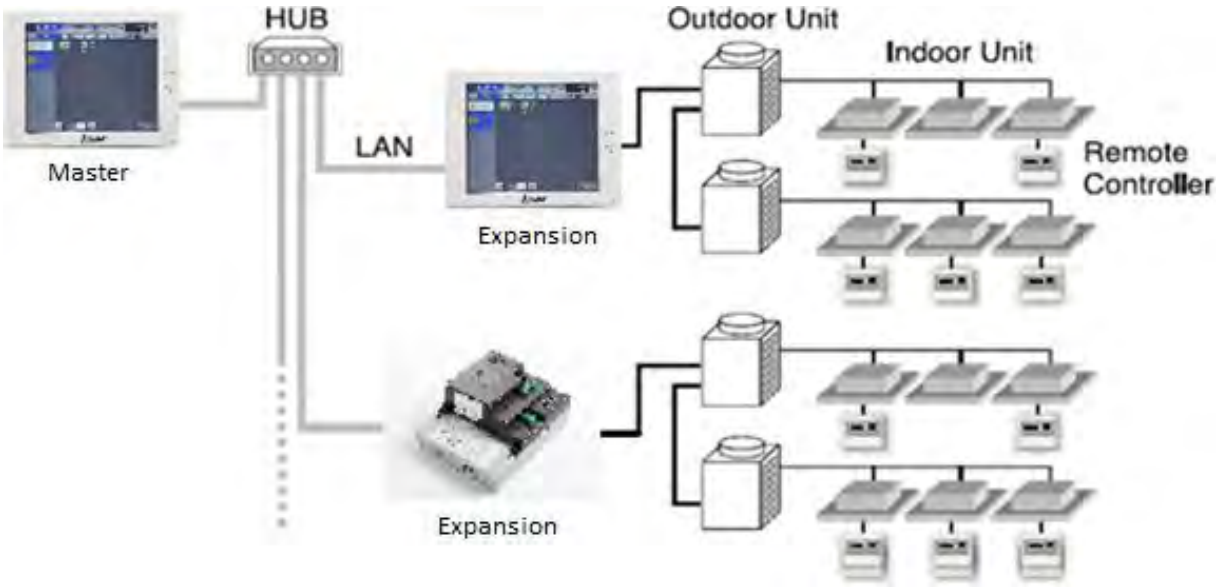
A. General:
1. Controller power and communications shall be via a common non-polar communications bus and shall operate at 30VDC.

B. Wiring:
1. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
2. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

C. Wiring type:
1. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
2. Network wiring shall be CAT-5 with RJ-45 connection.

4.3 CITY MULTI CONTROLS NETWORK

A. The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



System Configuration

4.4 CENTRALIZED CONTROLLER (WEB-ENABLED)

A. Master Centralized Controller:

1. The Master Centralized Controller shall be capable of controlling a maximum of two hundred
2. (200) indoor units across multiple CITY MULTI outdoor units with the use of three expansion controllers. The Master Centralized Controller shall be approximately 11-5/32” x 7-55/64” x 2-17/32” in size and shall be powered with an integrated 100-240 VAC power supply. The Master Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the Master Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the Master Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the master provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Master Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

Master Centralized Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *1. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3. Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group

Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4. When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S- Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following languages can be selected: Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese.	N/A	Collective
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: “Batch start/stop”, “Batch emergency stop” By pulse: “batch start/stop”, “Enable/disable remote controller” Output: “start/stop”, “error/Normal” *5. Requires the external I/O cables (PAC- YG10HA-E) sold separately.	*5 Collective	*5 Collective

3. All Master Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three expansion controllers for display of up to two hundred (200) indoor units on the main master centralized controller interface.
4. The Master Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.
5. Standard software functions shall be available so that the building manager can securely log into each master centralized controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Energy shall be available but are not included. The Energy Apportionment function shall require a LIC-Charge software license

B. Expansion Controller:

1. The Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the Master Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the master centralized controller. Up to three (3) expansion controllers can be connected to the master via a local IP network (and their IP addresses assigned on the master) to the master to allow for up to two hundred (200) indoor units to be monitored and controlled from the master interface.
2. The expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the master and configured to display their units on the main controller, the individual indoor units connected to the expansion can still be monitored and controlled from the interface of the expansion. The last command entered will take precedence, whether at the wall controller, the expansion or the master Centralized Controller.

C. Non Touch Screen, Networked Centralized Controller:

1. The Non Touch Screen, Networked Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple CITY MULTI outdoor units. The controller shall be approximately 8-1/2"x10" in size and shall be powered by its internal power supply. The controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, free contact interlock configuration and malfunction monitoring. The controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, temperature setting, fan speed setting, and airflow direction setting. Since the controller provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

Non Touch Screen, Networked Centralized Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Indoor unit modes: COOL/DRY/FAN/AUTO/HEAT. Lossnay unit modes: HEAT RECOVERY/BYPASS/AUTO Air to water (PWFY) modes: HEATING/HEATING ECO/HOT WATER/ANTI- FREEZE/COOLING PART 5 *Operation modes vary depending on the unit model connected. PART 6 ** Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.	Each Block, Group or Collective	Each Group
Set Temperature Range Limit	The range of room temperature setting can be limited by the initial setting depending on the indoor unit connected.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depend on indoor unit model.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	*Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *2. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group

Hold	Disables scheduled functions for indoor unit groups and their associated remote controller timers. *not available for general equipment	Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction and Reset filter). *3. Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group.	N/A	Each Group
Room Humidity	Displays the percent relative humidity in the space as sensed by the Smart ME Remote Controller	N/A	
Occupancy Sensor	Displays the occupancy icon on the group icon in the condition list page when the room is occupied (blue) or vacant (gray). *The Smart ME Remote Controller Occupancy sensor is required.	N/A	Each Group
Brightness Sensor	Displays the brightness icon on the group icon in the condition list when the space is determined to be bright (yellow) or dark (gray). *The Smart ME Remote Controller Brightness sensor is required.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4. When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following languages can be selected: Spanish, French, Japanese, German, Italian, Russian, Chinese, and Portuguese.	N/A	N/A

External Input / Output	By using accessory cables you can set and monitor the following. Input: By level: "Batch start/stop", "Batch emergency stop"; By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" *5. Requires the external I/O cables (PAC- YG10HA-E) sold separately.	*5 Collective	*5 Collective
M-Net	The "M-NET" LED lights, when AC power supply is turned ON. The LED blinks while M-NET is communicating.	N/A	Each Group (LED)
Collective ON/OFF	All the units can be operated / stopped with a DIP switch.	Collective	N/A
Measurement	Displays the Temperature and Humidity inputs of the AI Board. Supports graph display and data export.	N/A	Each Unit
AHC Status	Displays the status of the of the inputs and outputs of each Advanced HVAC Controller (DC-A2IO)		Each Unit
Free Contact Status	Displays the input/output status of the Free Contacts on the indoor units	N/A	Each Unit
Free Contact Interlock Control	Operation of indoor groups, general equipment or free contact outputs based on group(s) conditions or free contact(s) input states.	Each Group, Output or Collective	N/A
Data Back-up (PC)	Initial setting data can be exported to a PC.	Collective	N/A

1. All Non Touch Screen, Networked Centralized Controller shall be equipped with two RJ-45 Ethernet port to support interconnection with a network PC and BACnet/IP communication via a closed/direct Local Area Network (LAN). The controller shall be capable of performing initial settings online via a PC using the controller's initial setting browser or online/offline with the Initial Setting Tool.
2. Standard software functions shall be available so that the building manager can securely log into each controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Standard software functions shall not expire. Additional optional software functions of personal browser for PCs and MACs and Energy Allocation shall be available. The Energy Allocation function shall require Master Centralized Controller Energy Allocation Integrated System in conjunction with Non Touch Screen, Networked Centralized Controller.

4.5 GRAPHICAL USER INTERFACE

B. The Graphical User Interface (Integrated Centralized Control Web) shall require a field supplied PC or Tablet.

C. ICCW

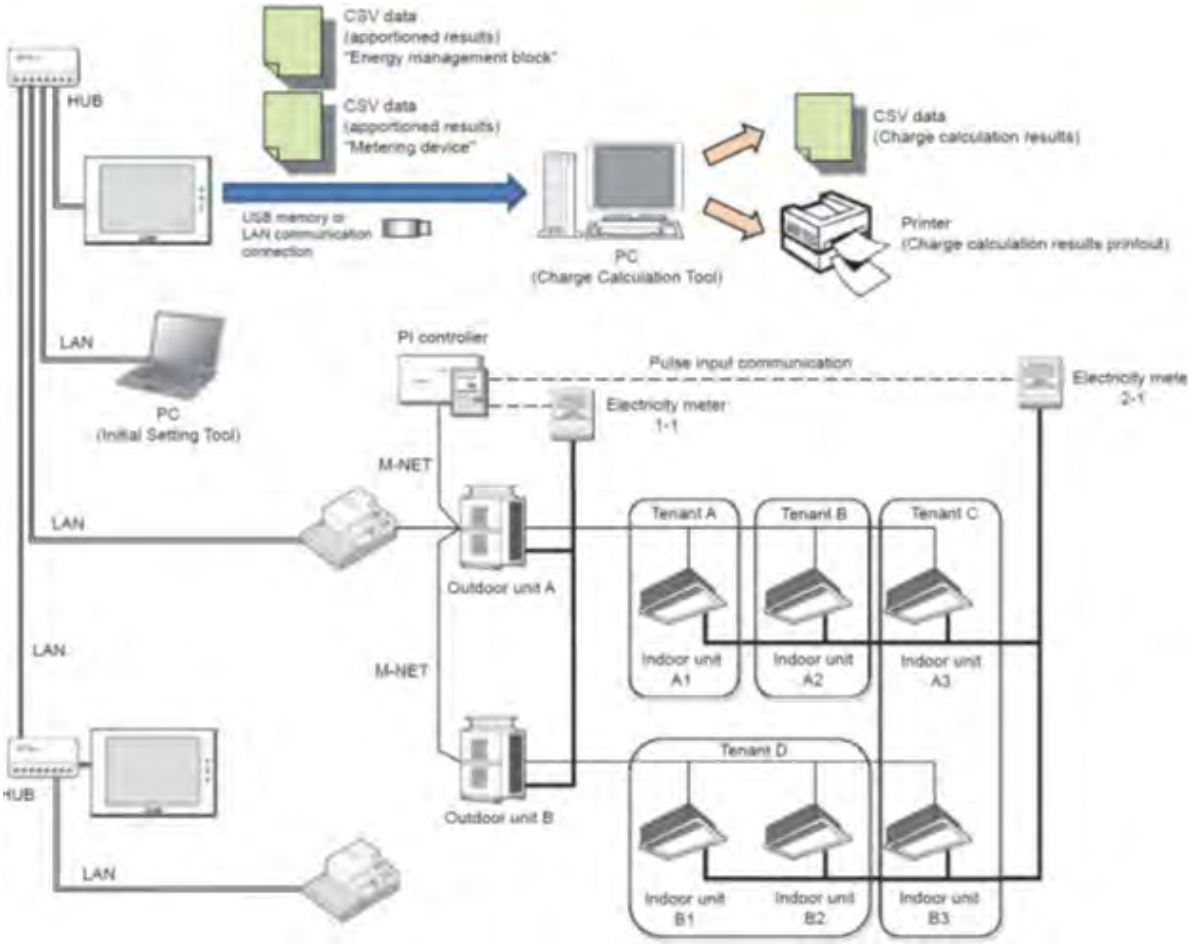
3. The Integrated Centralized Control Web System (ICCW) interface shall enable the user to control multiple networked central controllers and shall provide additional functions such as

energy apportionment from a single network PC configured with the Charge Calculation Tool. The ICCW shall be capable of controlling up to forty networked Centralized Controllers with a maximum of 2,000 indoor units across multiple CITY MULTI outdoor units. The ICCW shall be required if the user wants to simultaneously control more than 1 Centralized Controllers from a single PC or tablet using a single web browser session. Licensing per function, per Centralized Controller shall be required for the ICCW. Optional software features shall be available through the ICCW including energy apportionment and personalized web. These optional software features shall require the ICCW, advance purchase from the customer, and licensing from ICCW.

ICCW (Integrated System Software)	
Item	Details
ON/OFF	The units can turn ON and OFF for all floors or in a block, floor, or group of units.
Operation	The operation mode can be switched between COOL, DRY, FAN,
Modes	AUTO, and HEAT for all floors or in a block, floor, or group of units
Temperature Setting	Sets the temperature for a single group. Range of Temperature setting from 57°F – 87°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.
Fan Speed	The fan speed can be set to four stages for all floors or in a block, floor, or group of units
Air Direction	The air direction can be set in four vertical directions or to swing for all floors or in block, floor, or group of units. (The selectable air direction differs according to the model.)
Interlocked Unit ON/OFF LOSSNAY	If there is an interlocked unit (LOSSNAY), then the unit can be turned ON (strong/weak) or OFF for all floors or in a block, floor, or group of units. (Note that the ventilation mode cannot be selected for interlocked units.)
Local Operation Prohibit	The items for which operation with the local remote controller are to be prohibited can be selected for all floors or in a block, floor, or group of units. (The items that can be prohibited are ON/OFF, operation mode, set temperature and filter sign reset.)
Annual / Weekly Schedule	The annual/weekly schedule function can be used by registering the license. Two settings, such as seasonal settings for summer and winter, can be saved.
Power Rate Apportionment Charging	A watt-hour meter (WHM) with kWH pulse output is connected to calculate the air conditioning charges based on the amount each tenant's air-conditioner has operated. Five charging rates can be applied per day. ***OPTIONAL ENERGY APPORTIONMENT SOFTWARE (LIC- CHARGE) and PI Controller (PAC-Y60MCA) REQUIRED

History	Up to 3,000 items for the error history and up to 10,000 items for operation history can be saved. Each history file can be output as a daily report or monthly report in CSV format. (The operation history consists only of the operations carried out with the ICCW and is limited to some limited operation items.)
Operation Time Monitor	The cumulative operation time of each indoor unit can be viewed or output as a CSV format file. (This function is valid only when the
	charging function license is registered.)
Filter Sign Display Mask	The filter sign display at the remote controllers can be disabled.
Set Temperature Limit	The set temperature lower limit can be set for cooling and the upper limit for heating. (ME remote controller required)

4.6 ENERGY APPOINTMENT METHOD FOR CITY MULTI CENTRALIZED CONTROLLERS



CMCN System Configuration

D. System Overview

4. For centralized systems serving multiple tenants for which one-to-one electricity metering is not possible, an apportioned electricity billing function that attributes just the electrical energy consumed by each individual tenant's air conditioner is required. The Energy Apportionment function takes the information on the electrical energy usage gathered from Watt Hour Meters (WHM) connected to dedicated breaker panels serving the system's outdoor units and synthesizes it with the information on the operating status of the indoor units that is collected by the CITY MULTI centralized controller(s).

B. Watt Hour Meters

1. Requirements: The Watt Hour Meters (WHMs) to be used to read the electrical energy consumption of the outdoor units must be capable of a pulse output, which would be configured based on the current rating of the units. The associated current transformers/ transducers (CTs) must also be sized based on the current rating of either the individual outdoor units or the dedicated air conditioning electrical panels they are to be reading. The proper quantity of meters for a particular sized system must be selected in order to ensure sufficient resolution and hysteresis in the unit pulse output of the meters so as to ascribe an acceptable level of accuracy to the apportionment of energy usage for each tenant's system. The system is designed to work with any WHM capable of a pulse output that meets ANSI C12.20 class 0.2% or 0.5% accuracy standards.

2. Connection: The WHMs are to be physically connected to the integrated pulse input module or an external Mitsubishi Electric PI Controller if such an input is not available or if there is a wiring length limitation or installation hardship. The cable type of the interconnecting wiring shall be according to the wiring specifications of the WHM manufacturer.

C. CITY MULTI Centralized Controller Requirements

1. Licensing: Each centralized controller to which units are assigned that require the energy apportionment function must have the "LIC-Charge" software license purchased and properly unlocked in order to enable the operating status of the indoor units to be passed to the energy apportionment tool. The procedure for licensing the centralized controllers with this function and the necessary forms can be found on Mitsubishi Electric's technical documentation repository, mylinkdrive.com. Purchase Order information for the licenses will be required at the time of submission of the licensing request forms.

2. Dedicated master centralized controller for apportionment (no MNET connection).

3. A dedicated master centralized controller, for which the LIC-Charge license is purchased and the energy apportionment function enabled, must be provided in order to serve as the portal for exporting metering device and energy management data to a USB drive or to a PC via LAN connection. This means that by virtue of selecting this master centralized controller to serve this function, the MNET capability of this particular centralized controller will be disabled. All indoor units must be physically wired via MNET to other expansion centralized controllers, which must be physically wired via LAN with Static IP addresses and a network hub or switch to the master apportionment controller.

D. PC for collecting charge calculation results

1. A networked PC, which does not necessarily have to be dedicated to the task of collecting energy apportionment data, can be provided and loaded with the Charge Calculation Tool software for exporting data necessary to generate billing documentation to be performed by a third party. The system requirements of the PC are as follows:

Item	Requirements
CPU	1 GHz or better (at least 2 GHz recommended)
Memory	2GB or more
Screen Resolution	1024 x 768 or better
OS	Windows 7, Windows 8.1 (32bit/64bit)
System requirements	The system should meet the minimum requirement for Windows 7 or Windows 8.1 Net Framework 4.5 or later
Internal LAN port or LAN card	100 BASE-TX or better
Porting device	Mouse, etc.

PART 5 Ventilation Options

5.1 HIGH STATIC, CEILING-CONCEALED, DUCTED OUTSIDE AIR UNIT

A. General:

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Unit Cabinet:

1. The cabinet shall be ceiling-concealed, ducted with a fixed rear return and a horizontal discharge supply.

C. Fan:

1. Indoor unit shall feature adjustable external static pressure settings up to 1.00 in. WG.
2. The indoor unit fan shall be an assembly with one or two statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.

D. Filter:

1. Return air shall be filtered by a field-supplied filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. The unit shall be able to utilize VRF heating/cooling with intake air temperature ranging from 14FWB to 118FDB
2. In order to maximize efficiency of VRF (reverse cycle) heating operation, unit shall be capable of intake of unmixed or untreated 14FWB air directly into the unit. Below 14FWB (modifiable via dipswitch) the fan will switch to very low fan speed in order to reduce the effects of cold discharge air temperatures from the unit.
3. Leaving air temperature set point range shall be adjustable from 50FDB to 80FDB in cooling mode and 63FDB to 95FDB in heating mode.
4. The unit shall utilize a fan only mode from 59FDB to 63FDB in order to prevent cycling between modes.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. General requirements applicable to all components and systems included in Electric Work Prime Contract.

B. Products Installed but Not Furnished Under This Section
   1. Make all electrical connections to equipment shown on Drawings and furnished by other Prime Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Prime Contractor furnishing equipment. Provide disconnect switches, push button stations, and similar components, required but not furnished with equipment as shown on Drawings.

C. Related Sections
   1. Section 01 02 00 – Allowances.
   2. Section 01 04 00 – Administrative Requirements.
   3. Section 01 30 00 – Submittals.

1.2 REFERENCES

A.	AIA	American Institute of Architects
B.	AISC	American Institute of Steel Construction
C.	ANSI	American National Standards Institute
D.	ASTM	American Society of Testing Materials
E.	IEEE	Institute of Electric and Electronic Engineers
F.	IES	Illuminating Engineering Society
G.	NBFU	National Board of Fire Underwriters
H.	NEC	National Electric Code
I.	NEMA	National Electrical Manufacturers' Association
J.	NETA	International Electrical Testing Association
K.	NFPA	National Fire Protection Association
L.	UL	Underwriters' Laboratories, Inc.

1.3 SYSTEM DESCRIPTIONS

A. Testing of Existing Systems: Test each existing system scheduled for modification in presence of Owner’s Representative and issue report to Owner and Architect listing conditions found prior to any removals, relocations, or additions. Modified systems shall include (but are not limited to):
   1. Power Distribution
   2. Power Generation system
   3. Fire Alarm System
   4. Computer Network System
   5. Telephone System

B. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):
   1. All wiring and conduit for work specified in Project Manual and shown on Drawings.
   2. All electrical devices and equipment for work specified in Project Manual and shown on Drawings.
   3. Systems included, but not limited to:
      a. Electrical Distribution
      b. Electrical Connections
      c. Lighting
      d. Fire Alarm System
      e. Computer Network System
      f. Telephone System
      g. Television System

C. Electric Layouts: Arrange all panels, disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch plywood backboards for all surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 30 00 - Submittals and as modified below. Refer to submittal listing in each section for specific items required.

B. Shop Drawings
   1. Electric Layouts: Submit detailed drawings showing exact sizes and locations for approval before beginning work.

C. Samples
   1. Factory-Finished Surfaces: On all submittals, indicate standard factory color. Where more than one color is available, selection made by Architect from manufacturer's full range of colors.

D. Contract Closeout Submittals: Comply with requirements of Section 01 70 00, including submission of operating and maintenance instructions as item in "Electric Work Instructions" manual described in that section.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Codes and Standards: Comply with all applicable Federal, State and Local Building and Electrical Codes, Laws, Ordinances, and Regulations, and comply with all applicable NFPA, National Electrical Code and Utility Company requirements and regulations. Provide Underwriter's Laboratory Seal on all materials.
   2. Permits and Inspections: Obtain all approvals, tests, and inspections required by Architect, Engineer, Local Electrical Inspector, agent or agency specified in Project Manual, or National, State, or Local Codes and Ordinances.
      a. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.
      b. Furnish all materials and labor necessary for tests and pay all costs associated with tests and inspections.
      c. Conduct all tests under load for load balancing and where required by Codes, Regulations, Ordinances, or Technical Specification.
   3. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection
1. Take all reasonable precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
2. Replace all equipment damaged beyond reasonable repair as required by Architect.
3. Refinish any equipment with marks, stains, scratches, dents, etc., as required by Architect.

1.7 COORDINATION OF WORK

A. Cutting and Patching (as required for installation of components and systems included in Electric Work Prime Contract):
1. New Construction
a. Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric Work Prime Contract systems and components): Coordinate requirements with General Work Prime Contractor for inclusion in General Work Prime Contract. Furnish all necessary information (e.g. locations and sizes) to General Work Prime Contractor in ample time for installation of systems and components included in Electric Work Prime Contract.
b. Anchor Bolts: Deliver to General Work Prime Contractor all anchor bolts required for Electric Work Prime Contract construction that are to be installed in construction included in General Work Prime Contract.
c. Locate settings, check locations as installation in General Work Prime Contract progresses, and provide templates or holding fixtures as required to maintain proper accuracy.
2. Existing Construction: Unless otherwise specified, provide all cutting, patching, repairing and replacing of general work required for installation of systems and components included in Electric Work Prime Contract. Secure approval before cutting.
a. Anchor Bolts: Deliver to General Work Prime Contractor all anchor bolts required for Electric Work Prime Contract construction that are to be installed in construction included in General Work Prime Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

B. Rough Openings: Refer to Section 01 35 17 - Alteration Project Procedures.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Do not cut waterproofed floors or walls for admission of any equipment or materials and do not pierce any structural members without written permission.

B. Furnish and install all sleeves, inserts, panels, raceways, boxes, etc., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.

C. Unless otherwise noted elsewhere in Contract Documents, bear expense of all cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Work Prime Contract or damage done by Electric Work Prime Contract. Employ and pay Prime Contractor whose work is involved.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of all electrical systems and equipment furnished and installed in Electric Work Prime Contract.
   1. Coordinate and schedule time and place of all training through the Architect at the Owner’s convenience.
   2. Submit letters attesting to satisfactory completion of all instructions, including date of completion of instruction, names of persons in attendance and signature of Owner’s authorized representative.
   3. The following equipment and systems are included:
      a. Fire alarm system
      b. Computer network systems
      c. Telephone system

3.3 FIELD QUALITY CONTROL

A. Cleaning: Upon completion of system installations
   1. Provide full inspection of exposed finishes.
   2. Remove burrs, dirt, and construction debris.

   3. Repair damaged surfaces including chips, scratches, and abrasions. Damp Rag clean all electrical equipment, panels, boxes, and accessories.

END OF SECTION

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

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Underground feeder and branch-circuit cable.

C. Service entrance cable.

D. Metal-clad cable.

E. Wire and cable for 600 volts and less.

F. Wiring connectors.

G. Electrical tape.

H. Heat shrink tubing.

I. Oxide inhibiting compound.

J. Wire pulling lubricant.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 28 31 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

E. Section 31 23 16 - Excavation.

F. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

G. Section 31 23 23 - Earth Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2012 (NECA/NACMA 102).

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

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

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

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

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

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

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

P. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.

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

R. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

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

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

B. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

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

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

C. Nonmetallic-sheathed cable is not permitted.

D. Metal-clad cable is permitted only as follows:
   1. Where not otherwise restricted, may be used:
      a. Where concealed above accessible ceilings.
      b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
         1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
   2. In addition to other applicable restrictions, may not be used:
      a. Where not approved for use by the authority having jurisdiction.
      b. Where exposed to view.
      c. Where exposed to damage.
      d. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
      e. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.

E. Manufactured wiring systems are permitted only as follows:

   1. Concealed Dry Interior Locations: Use only building wire in raceway, building wire with Type THHN/THWN insulation in raceway, or metal clad cable.

   2. Exposed Dry Interior Locations: Use only building wire in raceway or building wire with Type THHN/THWN insulation in raceway.

   3. Above Accessible Ceilings: Use only building wire in raceway, building wire with Type THHN/THWN insulation in raceway, or metal clad cable.

   4. Wet or Damp Interior Locations: Use only building wire with Type THHN/THWN insulation in raceway.

   5. Exterior Locations: Use only building wire with Type THHN/THWN insulation in raceway.

   6. Underground Installations: Use only building wire with Type THHN/THWN insulation in raceway.

F. Use solid or stranded conductor for feeders and branch circuits 10 AWG and smaller.

G. Use stranded conductors for control circuits.

H. Use conductor not smaller than 12 AWG for power and lighting circuits.

I. Use conductor not smaller than 16 AWG for control circuits.

J. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

K. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

L. Conductor sizes are based on copper. Aluminum conductors shall not be used.

2.2 CONDUCTOR AND CABLE MANUFACTURERS

A. Cerro Wire LLC: www.cerrowire.com.

B. Industrial Wire & Cable, Inc: www.iewc.com.

C. Southwire Company: www.southwire.com.

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

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

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

C. Provide new conductors and cables manufactured not more than one year prior to installation.

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

E. Comply with NEMA WC 70.

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

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

H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

I. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

J. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
   2. Control Circuits: 14 AWG.

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

L. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
a. 208Y/120 V, 3 Phase, 4 Wire System:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral/Grounded: White.
b. Equipment Ground, All Systems: Green.
c. Isolated Ground, All Systems: Green with yellow stripe.
d. Travelers for 3-Way and 4-Way Switching: Purple.
e. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
f. For control circuits, comply with manufacturer's recommended color code.

2.4 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
1. Copper Building Wire:
a. Cerro Wire LLC: www.cerrowire.com.
b. Encore Wire Corporation: www.encorewire.com.
c. Southwire Company: www.southwire.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
1. Feeders and Branch Circuits:
a. Size 10 AWG and Smaller: Solid.
b. Size 8 AWG and Larger: Stranded.
2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
a. Size 4 AWG and Larger: Type XHHW-2.

F. Conductor: Copper.

G. Insulation Voltage Rating: 600 volts.

H. Insulation: NFPA 70, Type THHN/THWN.

2.5 SERVICE ENTRANCE CABLE

A. Manufacturers:
1. Copper Service Entrance Cable:
a. Cerro Wire LLC: www.cerrowire.com.
b. Encore Wire Corporation: www.encorewire.com.
c. Southwire Company: www.southwire.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Service Entrance Cable for Above-Ground Use: NFPA 70, Type SE multiple-conductor cable listed and labeled as complying with UL 854, Style R.

C. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44, Type RHH/RHW-2.

D. Conductor Stranding: Stranded.

E. Insulation Voltage Rating: 600 V.

2.6 METAL-CLAD CABLE

A. Manufacturers:
1. Encore Wire Corporation: www.encorewire.com.
2. Southwire Company: www.southwire.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

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

C. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide oversized neutral conductors where indicated or required.

G. Provide dedicated neutral conductor for each phase conductor where indicated or required.

H. Grounding: Full-size integral equipment grounding conductor.
1. Provide additional isolated/insulated grounding conductor where indicated or required.

I. Armor: Steel, interlocked tape.

J. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

K. Description: NFPA 70, Type MC.

L. Conductor: Copper.

M. Insulation Voltage Rating: 600 volts.

N. Insulation Temperature Rating: 75 degrees C.

O. Insulation Material: Thermoplastic.

P. Armor Material: Steel.

Q. Armor Design: Interlocked metal tape.

2.7 WIRING CONNECTORS

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

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:
1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.

2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
7. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
a. 3M: www.3m.com.
b. Ideal Industries, Inc: www.idealindustries.com.
c. Substitutions: See Section 01 60 00 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
a. Burndy: www.burndy.com.
b. Ilsco: www.ilsco.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
a. Burndy: www.burndy.com.
b. Ilsco: www.ilsco.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

2.8 WIRING ACCESSORIES

A. Electrical Tape:
1. Manufacturers:
a. 3M: www.3m.com.
b. Substitutions: See Section 01 60 00 - Product Requirements.
2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.

3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
a. 3M: www.3m.com.
b. Burndy: www.burndy.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
1. Manufacturers:
a. Burndy: www.burndy.com.
b. Ideal Industries, Inc: www.idealindustries.com.
c. Ilsco: www.ilsco.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
1. Manufacturers:
a. 3M: www.3m.com.
b. Ideal Industries, Inc: www.idealindustries.com.
c. Substitutions: See Section 01 60 00 - Product Requirements.

E. Solderless Pressure Connectors:

F. Spring Wire Connectors:

G. Compression Connectors:

PART 3 EXECUTION

3.1 EXAMINATION

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

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

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

D. Verify that raceway installation is complete and supported.

E. Verify that field measurements are as shown on the drawings.

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

3.2 PREPARATION

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

3.3 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated and routing is not shown, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location shown.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
      a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors as required to account for ampacity derating.
      c. Size raceways, boxes, etc. to accommodate conductors.
   8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
      a. Branch circuits fed from ground fault circuit interrupter (GFCI) circuit breakers.
      b. Branch circuits fed from feed-through protection of GFI receptacles.
      c. Branch circuits with dimming controls.
      d. Branch circuits with isolated grounding conductor.
   9. Provide oversized neutral/grounded conductors where indicated and as specified below.
      a. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.

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

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

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

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

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

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

H. Terminate cables using suitable fittings.
   1. Metal-Clad Cable (Type MC):
      a. Use listed fittings.

b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

I. Install conductors with a minimum of 12 inches of slack at each outlet.

J. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

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

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

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

N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
3. Wet Locations: Use heat shrink tubing.

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

P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

Q. Identify conductors and cables in accordance with Section 26 05 53.

R. Color Code Legend: Provide identification label identifying color code for ungrounded conductors at each piece of feeder or branch-circuit distribution equipment when premises have feeders or branch circuits served by more than one nominal voltage system.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

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

U. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1.

V. Route wire and cable as required to meet project conditions.
   1. Wire and cable routing indicated is approximate unless dimensioned.
   2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
   3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.

W. Use wiring methods indicated.

X. Pull all conductors into raceway at same time.

Y. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

Z. Protect exposed cable from damage.

AA. Support cables above accessible ceiling, using spring metal clips or metal or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

AB. Use suitable cable fittings and connectors.

AC. Neatly train and lace wiring inside boxes, equipment, and panelboards.

AD. Clean conductor surfaces before installing lugs and connectors.

AE. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

AF. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

AG. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

AH. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

AI. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

3.4 FIELD QUALITY CONTROL

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

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

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

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

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Ground bars.

D. Grounding and bonding components.

E. Provide all components necessary to complete the grounding system(s)

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; Institute of Electrical and Electronic Engineers; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

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

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.6 SUBMITTALS

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

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

C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

D. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

1.8 DELIVERY, STORAGE, AND HANDLING

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

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

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

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

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

D. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer/Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Metal Building or Structure Frame:
      a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
   3. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
      a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

F. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
      b. Metal gas piping.

2.2 GROUNDING AND BONDING COMPONENTS

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

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

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
   4. Manufacturers - Mechanical and Compression Connectors:
      a. Burndy: www.burndy.com.
      b. Harger Lightning & Grounding: www.harger.com.
      c. Thomas & Betts Corporation: www.tnb.com.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   5. Manufacturers - Exothermic Welded Connections:
      a. Burndy: www.burndy.com.
      b. Cadweld, a brand of Erico International Corporation: www.erico.com.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.
   4. Manufacturers:
      a. Erico International Corporation: www.erico.com.
      b. Harger Lightning & Grounding: www.harger.com.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.
   1. Product: As manufactured by Copperweld, Erico, Ilsco, O-Z Gedney, Thomas & Betts.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Exothermic Connections:
   1. Product: As manufactured by Cadweld, Copperweld, Erico.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

C. Wire: Stranded copper.

D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

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

D. Verify existing conditions prior to beginning work.

3.2 INSTALLATION

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

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 26 05 53.

E. Provide bonding to meet requirements described in Quality Assurance.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

3.3 FIELD QUALITY CONTROL

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

B. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

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

D. Perform inspections and tests listed in NETA ATS, Section 7.13.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

B. Section 26 05 37 - Boxes: Additional support and attachment requirements for boxes.

C. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

D. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

E. Conduit and equipment supports.

F. Anchors and fasteners.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.

D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

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

G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

1.7 DELIVERY, STORAGE, AND HANDLING

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

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
b. Erico International Corporation: www.erico.com.

c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
d. Thomas & Betts Corporation: www.tnb.com.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
1. Manufacturers:
a. Cooper Crouse-Hinds, a division of Eaton Corporation;www.cooperindustries.com.
b. Erico International Corporation: www.erico.com.
c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
d. Thomas & Betts Corporation: www.tnb.com.
e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
3. Channel Material:
a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Manufacturers:
a. Cooper B-Line, a division of Eaton Corporation; : www.cooperindustries.com.
b. Thomas & Betts Corporation: www.tnb.com.
c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.
e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
a. Equipment Supports: 1/2 inch diameter.
b. Busway Supports: 1/2 inch diameter.
c. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
d. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
f. Outlet Boxes: 1/4 inch diameter.
g. Luminaires: 1/4 inch diameter.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

a. Comply with MFMA-4.
b. Channel Material: Use galvanized steel.
c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

2.2 MANUFACTURERS

A. Thomas & Betts Corporation: www.tnb.com.

B. Threaded Rod Company: www.threadedrod.com.

2.3 MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; galvanized.

C. Anchors and Fasteners:
1. Steel Structural Elements: self-drilling threaded rod anchors, equal to Elco Textron#ZE655.
2. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
3. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
4. Solid Masonry Walls: Use expansion anchors or preset inserts.
5. Sheet Metal: Use sheet metal screws.
6. Wood Elements: Use wood screws.

D. Formed Steel Channel:
1. Substitutions: See Section 01 60 00 - Product Requirements.

E. Steel Spring Clips:

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.

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

3.2 INSTALLATION

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

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Field-Welding (where approved by Engineer/Architect): Comply with Section 05 50 00.

I. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Box Support and Attachment: Also comply with Section 26 05 37.

K. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.

L. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.

M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

N. Secure fasteners according to manufacturer's recommended torque settings.

O. Remove temporary supports.

P. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

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

B. Inspect support and attachment components for damage and defects.

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

D. Correct deficiencies and replace damaged or defective support and attachment components.

E. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
   1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
   2. Do not drill or cut structural members.

F. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION

SECTION 26 05 34

CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Flexible metal conduit (FMC).

C. Liquid tight flexible metal conduit (LFMC).

D. Electrical metallic tubing (EMT).

E. Rigid polyvinyl chloride (PVC) conduit.

F. Liquid tight flexible nonmetallic conduit (LFNC).

G. Conduit fittings.

H. Accessories.

I. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems.

E. Section 26 05 37 - Boxes.

F. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

G. Section 27 13 43 - Communications Services Cabling.

H. Section 31 23 16 - Excavation.

I. Section 31 23 23 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2013.

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association; 2005.

H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2013.

I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2015.

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

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

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

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

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

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

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
   4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
   5. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

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

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

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

D. Product Data: Provide for metallic conduit, flexible metal conduit, liquid tight flexible metal conduit, metallic tubing, nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

C. All materials and equipment shall be listed and labeled by a nationally recognized testing laboratory such as UL. All work to be performed in accordance with the NEC. Contractor to secure a third party inspector having local authority and jurisdiction. Contractor to provide certificate of inspection prior to final request for payment.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

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

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

C. Underground:
1. Under Slab on Grade: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows or PVC-coated galvanized steel rigid metal conduit elbows for bends.
6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.
2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.

3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit where emerging from concrete.

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

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

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

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit or rigid PVC conduit.

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

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

N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

P. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquid tight flexible metal conduit.
3. Vibrating equipment includes, but is not limited to:
   a. Motors.
   b. Space Heaters.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.2 CONDUIT REQUIREMENTS

A. Electrical Service Conduits: Also comply with Section 26 21 00.

B. Communications Systems Conduits: Also comply with Section 27 13 43.

C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

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

F. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 3/4 inch (21 mm) trade size.
2. Branch Circuit Homeruns: 1/2inch inch (16mm mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.

4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
5. Underground, Interior: 3/4 inch (21 mm) trade size.
6. Underground, Exterior: 1 inch (27 mm) trade size.

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

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

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

C. Fittings:
1. Manufacturers:
a. Bridgeport Fittings Inc: www.bptfittings.com.
b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use set screw and compression (gland) type fittings.

2.4 METAL CONDUIT

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedtube.com.
a. Picoma; : www.picoma.com.
2. Wheatland Tube Company: www.wheatland.com.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

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

A. Manufacturers:
1. Thomas & Betts Corporation: www.tnb.com.
2. Robroy Industries: www.robroy.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

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

C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

D. PVC-Coated Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.

3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.6 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

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

C. Fittings:
1. Manufacturers:
a. Bridgeport Fittings Inc: www.bptfittings.com.
b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.

D. Description: Interlocked steel construction.

E. Fittings: NEMA FB 1.

2.7 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

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

C. Fittings:
1. Manufacturers:
a. Bridgeport Fittings Inc: www.bptfittings.com.
b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.

D. Description: Interlocked steel construction with PVC jacket.

E. Fittings: NEMA FB 1.

2.8 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com.
2. Picoma; : www.picoma.com.
3. Wheatland Tube Company: www.wheatland.com.

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

C. Fittings:
1. Manufacturers:
a. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
b. Thomas & Betts Corporation: www.tnb.com.
c. Substitutions: See Section 01 60 00 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.
4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
5. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

D. Description: ANSI C80.3; galvanized tubing.

E. Fittings and Conduit Bodies: NEMA FB 1; steel compression type.

2.9 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:
1. Cantex Inc: www.cantexinc.com.
2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
3. JM Eagle: www.jmeagle.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

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

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

D. Description: NEMA TC 2; Schedule 80 PVC.

E. Fittings and Conduit Bodies: NEMA TC 3.

2.10 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

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

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
   1. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

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

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

D. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 INSTALLATION

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

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

F. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated and routing is not shown, determine exact routing required.
   3. Conceal all conduits unless specifically indicated to be exposed.
   4. Unless otherwise approved, do not route conduits exposed:
      a. Across floors.
      b. Across roofs.
      c. Across top of parapet walls.
      d. Across building exterior surfaces.
   5. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

6. Arrange conduit to maintain adequate headroom, clearances, and access.
7. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
8. Arrange conduit to provide no more than 150 feet between pull points.
9. Route conduits above water and drain piping where possible.
10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
13. Group parallel conduits in the same area together on a common rack.

G. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
5. Use conduit clamp to support single conduit from beam clamp or threaded rod.
6. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
7. Use of wire for support of conduits is not permitted.
8. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

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

I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.

5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

J. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 16 and Section 31 23 23.
2. Minimum Cover, Unless Otherwise Indicated or Required:
a. Underground, Exterior: 24 inches.
b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

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

L. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

M. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

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

3.3 FIELD QUALITY CONTROL

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

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

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

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

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

3.5 PROTECTION

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

B. Install conduit securely, in a neat and workmanlike manner, as specified in NECA 1.

C. Install steel conduit as specified in NECA 101.

D. Install nonmetallic conduit in accordance with manufacturer's instructions.

E. Arrange supports to prevent misalignment during wiring installation.

F. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

G. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

H. Fasten conduit supports to building structure and surfaces under provisions of Section 26 05 29.

I. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

J. Do not attach conduit to ceiling support wires.

K. Arrange conduit to maintain headroom and present neat appearance.

L. Route exposed conduit parallel and perpendicular to walls.

M. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

N. Route conduit in and under slab from point-to-point.

O. Do not cross conduits in slab.

P. Maintain adequate clearance between conduit and piping.

Q. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

R. Cut conduit square using saw or pipe cutter; de-burr cut ends.

S. Bring conduit to shoulder of fittings; fasten securely.

T. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

U. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

V. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.

W. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

X. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

Y. Provide suitable pull string in each empty conduit except sleeves and nipples.

Z. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

AA. Ground and bond conduit under provisions of Section 26 05 26.

AB. Identify conduit under provisions of Section 26 05 53.

END OF SECTION

SECTION 26 05 37

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Wall and ceiling outlet boxes.

D. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 27 26 - Wiring Devices:
   1. Wall plates.
   2. Additional requirements for locating boxes for wiring devices.

E. Section 26 27 26 - Wiring Devices: Wall plates in finished areas.

F. Section 27 15 23 - Communications Optical Fiber Cabling. Additional requirements for communications systems outlet boxes.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2013 (ANSI/NEMA OS 1).

E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 2013 (ANSI/NEMA OS 2).

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

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

H. SCTE 77 - Specification for Underground Enclosure Integrity; Society of Cable Telecommunications Engineers; 2013 (ANSI/SCTE 77).

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

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

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

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

D. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

B. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
13. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    b. Communications Systems Outlets: Comply with Section 27 10 05.
    c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
14. Wall Plates: Comply with Section 26 27 26.
15. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
    b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com.
    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com.
    d. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
    e. Thomas & Betts Corporation: www.tnb.com.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 Environment Type, Unless Otherwise Indicated:
      a. Indoor Clean, Dry Locations: Type 1, painted steel.
      b. Outdoor Locations: Type 3R, painted steel.
   3. Junction and Pull Boxes Larger Than 100 cubic inches:
      a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
   4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
      a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
      b. Back Panels: Painted steel, removable.
      c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
   5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
   6. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
      b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
      c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MANUFACTURERS

A. Subject to requirements, manufacturers offering products include, but are not limited to, the following:
   1. Appleton Electric: www.appletonelec.com.
   2. Raeco/Hubbell
   3. Steel City/Thomas&Betts
   4. Hoffman

2.3 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.

B. Cast Boxes: NEMA FB 1, Type FD, cast feral alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

C. Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.4 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

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

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

3.2 INSTALLATION

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

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

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

D. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

E. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

F. Box Locations:
   1. Locate boxes to be accessible.
   2. Locate boxes as required for devices installed under other sections or by others.
      a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
   3. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
   4. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.

G. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

H. Install boxes plumb and level.

I. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

J. Install boxes as required to preserve insulation integrity.

K. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

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

M. Identify boxes in accordance with Section 26 05 53.

N. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.

O. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.

P. Coordinate installation of outlet boxes for equipment connected under Section 26 27 17.

Q. Set wall mounted boxes at elevations to accommodate mounting heights indicated.

R. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
   1. Adjust box locations up to 10 feet if required to accommodate intended purpose.

S. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

T. Maintain headroom and present neat mechanical appearance.

U. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

V. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

W. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

X. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

Y. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

Z. Use flush mounting outlet box in finished areas.

AA. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only.

BB. Coordinate masonry cutting to achieve neat opening.

CC. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems. AC. Locate outlet boxes so that wall plates do not span different building finishes.

DD. Locate outlet boxes so that wall plates do not cross masonry joints.

EE. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. AF. Use stamped steel bridges to fasten flush mounting outlet box between studs.

FF. Install flush mounting box without damaging wall insulation or reducing its effectiveness. AH. Use adjustable steel channel fasteners for hung ceiling outlet box.

GG. Do not fasten boxes to ceiling support wires.

HH. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

II. Use gang box where more than one device is mounted together. Do not use sectional box. AL. Use gang box with plaster ring for single device outlets.

JJ. Use cast outlet box in exterior locations exposed to the weather and wet locations.

3.3 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.

3.4 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.5 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Warning signs and labels.

G. Field-painted identification of conduit.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting.

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

C. Section 26 27 26 - Wiring Devices - Lutron: Device and wall plate finishes; factory pre-marked wall plates.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

C. ASTM D 709 - Standard Specification for Laminated Thermosetting Materials; 2001 (Reapproved 2007).

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

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

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

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

C. Product Data: Provide catalog data for nameplates, labels, and markers.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
a. Switchgear:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
b. Main Distribution Panel:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
c. Motor Control Centers:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
d. Panelboards:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
(a) All branch circuit breakers shall be numbered.

5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

e. Enclosed switches, circuit breakers, and motor controllers:
1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.

f. Busway:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Provide identification at maximum intervals of 40 feet.
5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.

g. Transfer Switches:
1) Identify voltage and phase.
2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.
b. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.

3. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

4. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
a. Minimum Size: 3.5 by 5 inches.
b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
a. At each source and load connection.
b. Within boxes when more than one circuit is present.
c. Within equipment enclosures when conductors and cables enter or leave the enclosure.

C. Buried Electrical Lines: Underground warning tapes.

D. Communication Cabinets: Nameplates.

E. Control Device Station: Labels.

F. Electrical Distribution and Control Equipment Enclosures: Nameplates.

G. Junction Box Load Connections: Wire markers.

H. Outlet Box Load Connections: Wire markers.

I. Panel Gutter Load Connections: Wire markers.

J. Pull Box Load Connections: Wire markers.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
   2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
      a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
   3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
   4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
   5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Manufacturers:
      a. Brady Corporation: www.bradyid.com.
      b. Brother International Corporation: www.brother-usa.com.
      c. Panduit Corp: www.panduit.com.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. System designation where applicable:
         1) Fire Alarm System: Identify with text "FIRE ALARM".
      b. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. System Designation: 1 inch.
      b. Equipment Designation: 1/2 inch.
   5. Color:
      a. Normal Power System: White text on black background.

D. Manufacturers:
   1. Seton Identification Products: www.seton.com.

E. Nameplates: Engraved three-layer laminated plastic, white letters on red background.

F. Plastic: Conform to ASTM D 709.

G. Letter Size:
   1. Use 1/4 inch letters for identifying grouped equipment and loads.

H. Labels: Thermal adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:
   1. Brady Corporation: www.bradyid.com.
   2. Seton Identification Products: www.seton.com.
   3. Panduit Corp: www.panduit.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
   1. Do not use handwritten text.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

H. Description: Vinyl cloth type self-adhesive wire markers.

I. Color: Black on white.

J. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

2.4 VOLTAGE MARKERS

A. Manufacturers:
   1. Brady Corporation: www.bradyid.com.
   2. Brimar Industries, Inc: www.brimar.com.
   3. Seton Identification Products: www.seton.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
   2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
   4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

E. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
   2. Markers for System Identification:
      a. Emergency Power System: Text "EMERGENCY".

b. Other Systems: Type of service.

F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Brady Corporation: www.bradyid.com.
2. Seton Identification Products: www.seton.com.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color: Tape for Buried Power Lines: Black text on yellow background.

2.6 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
1. Materials:
2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

D. Description: 3 inch wide polyethylene tape, detectable type colored yellow with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

B. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.

7. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

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

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

C. Install nameplates and labels parallel to equipment lines.

D. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Time switches.

B. Outdoor photo controls.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 37 - Boxes.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

E. Section 26 51 00 - Interior Lighting.

F. Section 26 56 00 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
   3. Notify Engineer/Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

   1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

A. See Section 01 70 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all occupancy sensors.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

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

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

C. Products for Switching of Electronic LED Ballasts: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 TIME SWITCHES

A. Manufacturers:
1. Intermatic, Inc; :www.intermatic.com.
2. Paragon, a brand of Invensys Controls; www.invensyscontrols.com.
3. Tork, a division of NSI Industries LLC; www.tork.com.

2.3 OUTDOOR PHOTO CONTROLS

A. Manufacturers:
1. Substitutions: See Section 01 60 00 - Product Requirements.
2. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated

C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of lighting control devices provided under this section.

D. Install lighting control devices in accordance with manufacturer's instructions.

E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

F. Install lighting control devices plumb and level and held securely in place.

G. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.

H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

I. Outdoor Photo Control Locations:
   1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
   2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

J. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

K. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

L. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

M. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

3.4 FIELD QUALITY CONTROL

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

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Enginee/rArchitect. Record settings in written report to be included with submittals.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 70 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 70 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner’s personnel on operation, adjustment, programming, and maintenance of lighting control devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2013 (ANSI/NEMA PB 1.1).

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

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

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 67 - Panelboards; Current Edition, Including All Revisions.

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

M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

N. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

O. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

P. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

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

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

F. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

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

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

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance, manufacturers offering products include, but are not limited to, the following:
1. Square D Products
2. Siemens Industry, Inc: www.sea.siemens.com..
3. Schneider Electric; www.schneider-electric.us.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

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

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature:
a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
2. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
3. Label equipment utilizing series ratings as required by NFPA 70.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide 200 percent rated neutral bus and lugs where indicated or where oversized neutral conductors are provided.
3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

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

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.
2. Boxes: Galvanized steel unless otherwise indicated.
   a. Provide wiring gutters sized to accommodate the conductors to be installed.
   b. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

L. Load centers are not acceptable.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:
1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers unless otherwise indicated.
3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

F. Description: NEMA PB 1, circuit breaker type.

G. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.

H. Minimum integrated short circuit rating: As indicated.
1. 208 Volt Panelboards: 10,000 amperes rms symmetrical.

I. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.

J. Enclosure: NEMA PB 1, Type 1, 6.5 inches deep, 26 inches wide, cabinet box.

K. Cabinet Front: Surface type, fastened with hinge and latch, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

F. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

G. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.

H. Minimum Integrated Short Circuit Rating: As indicated.
1. 208 Volt Panelboards: 10,000 amperes rms symmetrical.

I. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.
1. Type SWD for lighting circuits.
2. Type HACR for air conditioning equipment circuits.
3. Do not use tandem circuit breakers.

J. Enclosure: NEMA PB 1, Type 1.

K. Cabinet Box: 6 inches deep, 20 inches wide for 208.

L. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
8. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
9. Do not use tandem circuit breakers.
10. Do not use handle ties in lieu of multi-pole circuit breakers.
11. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.6 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

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

3.2 INSTALLATION

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

B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

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

D. Provide required supports in accordance with Section 26 05 29.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

I. Provide grounding and bonding in accordance with Section 26 05 26.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
   2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

J. Install all field-installed branch devices, components, and accessories.

K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

L. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.

M. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

N. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

O. Provide filler plates to cover unused spaces in panelboards.

P. Identify panelboards in accordance with Section 26 05 53.

Q. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

R. Provide identification nameplate for each panelboard in accordance with Section 26 05 53.

S. Provide arc flash warning labels in accordance with NFPA 70.

T. Ground and bond panelboard enclosure according to Section 26 05 26.

3.3 FIELD QUALITY CONTROL

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

B. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

C. Perform field inspection and testing in accordance with Section 01 40 00.

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

E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1. Tests listed as optional are not required.

F. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

G. Test GFCI circuit breakers to verify proper operation.

H. Test AFCI circuit breakers to verify proper operation.

I. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

J. Correct deficiencies and replace damaged or defective panelboards or associated components.

K. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.4 ADJUSTING

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

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

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

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

END OF SECTION

SECTION 26 27 17

EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

A. Section 26 05 34 - Conduit.

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).

C. Section 26 05 37 - Boxes.

D. Section 26 27 26 - Wiring Devices.

E. Section 26 28 18 - Enclosed Switches.

1.3 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).

B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2012.

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

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

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 26 28 18 and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 27 26.

D. Wire and Cable: As specified in Section 26 05 19.

E. Boxes: As specified in Section 26 05 37.

2.2 EQUIPMENT CONNECTIONS

A. Refer to equipment Schedules on drawing for specific requirements for each piece of equipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 37 - Boxes.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 27 17 - Equipment Wiring: Cords and plugs for equipment.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).

E. NEMA WD 6 - Wiring Device -- Dimensional Specifications; National Electrical Manufacturers Association; 2012.

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

G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

K. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Notify Engineer/Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Operation and Maintenance Data:
   1. GFCI Receptacles: Include information on status indicators.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Design Make: Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. Hubbell Incorporated: www.hubbell-wiring.com.

C. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
   1. Substitutions: See Section 01 60 00 - Product Requirements.

D. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.

2.2 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI protection for receptacles installed within 6 feet of sinks.

E. Provide GFCI protection for receptacles installed in kitchens.

F. Unless noted otherwise, do not use combination switch/receptacle devices.

2.3 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: Ivory with ivory nylon wall plate.

C. Wiring Devices Installed in Wet or Damp Locations: Ivory with specified weatherproof cover.

2.4 ALL WIRING DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

B. Finishes:
1. Wiring Devices Installed in Finished Spaces: Ivory with nylon wall plate unless otherwise indicated.

2.5 WALL SWITCHES

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com.
2. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
1. Products:
a. Similar to P&S 20AC Series.

2.6 RECEPTACLES

A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
a. Products:
1) Similar to P&S 5362 Series.
2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
a. Products: Similar to P&S 3232.

C. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
      a. Products:
         1) Similar to P&S2095.
         2) Substitutions: See Section 01 60 00 - Product Requirements.
   3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
      a. Products:
         1) Similar to P&S 2095DSWRBK.

2.7 WALL PLATES

A. Manufacturers:
   1. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Weatherproof Covers for Wet or Damp Locations: Gasketed, thermoplastic, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected. Similar to P&S WIUFC10S.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.

C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches above finished floor.
      b. Receptacles: 18 inches above finished floor or 6 inches above counter.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
   5.

D. Install wiring devices in accordance with manufacturer's instructions.

E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

N. Identify wiring devices in accordance with Section 26 05 53.

O. Install identification label for all receptacles in accordance with Section 26 05 26 indicating serving branch circuit.

3.4 FIELD QUALITY CONTROL

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

B. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.

C. Inspect each wiring device for damage and defects.

D. Operate each wall switch with circuit energized to verify proper operation.

E. Test each receptacle to verify operation and proper polarity.

F. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

G. Inspect each surge protection receptacle to verify surge protection is active.

H. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Engineer/Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 17

ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

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

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

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

I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

K. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of circuit breaker upon request.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to conformance, manufacturers offering products include, but are not limited to, the following:
1. Schneider Electric. www.schneider-electric.us.
2. Square D Products.
3. Eaton Corporation: www.eaton.com.
4. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

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

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
   2. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

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

G. Provide thermal magnetic circuit breakers unless otherwise indicated.

H. Provide electronic trip circuit breakers where indicated.

I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
   3. Provide surface-mounted enclosures unless otherwise indicated.

L. Provide externally operable handle with means for locking in the OFF position.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:
   1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
   2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   3. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

C. Conductor Terminations:
   1. Provide compression lugs where indicated.
   2. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

E. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

F. Provide the following circuit breaker types where indicated:
1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

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

3.2 INSTALLATION

A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.

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

D. Provide required supports in accordance with Section 26 05 29.

E. Install enclosed circuit breakers plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

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

H. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

3.3 FIELD QUALITY CONTROL

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

B. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

C. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

E. Test GFCI circuit breakers to verify proper operation.

F. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

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

3.5 CLEANING

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

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

END OF SECTION

SECTION 26 28 18

ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2013.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

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

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Engineer/Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance, manufacturers offering products include, but are not limited to, the following:
1. Schneider Electric: www.schneider-electric.us.
2. Square D Products
3. Eaton Corporation: www.eaton.com.

B. Schneider Electric; Square D Products: www.schneider-electric.us.

C. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

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

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating: Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

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

J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
b. Outdoor Locations: Type 3R.
2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy Duty Switches:
1. Comply with NEMA KS 1.
2. Conductor Terminations:
a. Provide mechanical lugs unless otherwise indicated.
b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

O. Provide the following features and accessories where indicated or where required to complete installation:
1. Hubs: As required for environment type; sized to accept conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

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

3.2 INSTALLATION

A. Install enclosed switches in accordance with manufacturer's instructions.

B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.

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

D. Provide required supports in accordance with Section 26 05 29.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

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

H. Identify enclosed switches in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

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

B. Perform field inspection in accordance with Section 01 40 00.

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

D. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

E. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

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

3.5 CLEANING

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

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

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Exit signs.

D. Drivers.

E. Emergency Battery Units..

F. Lamps.

G. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 26 05 37 - Boxes.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

C. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

D. Section 26 56 00 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; Illuminating Engineering Society; 2002 (Reaffirmed 2008).

B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.

C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

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

H. NFPA 101 - Life Safety Code; National Fire Protection Association; 2015.

I. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

J. UL 1598 - Luminaires; Current Edition, Including All Revisions.

K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition,

Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Engineer/Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

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

B. Shop Drawings:
1. Provide photometric calculations where luminaires are proposed for substitution.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
1. LED Luminaires:
a. Include estimated useful life, calculated based on IES LM-80 test data.
2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
3. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

D. Provide photometric calculations of lighting fixtures.

E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

F. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

A. See Section 01 70 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

C. Provide five year pro-rata warranty for batteries for emergency lighting units.

D. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.1 MANUFACTURERS - LUMINAIRES

A. Subject to compliance, manufacturers offering products include, but are not limited to, the following:
1. Hubbell Lighting, Inc: www.hubbelllighting.com.
2. Columbia Lighting, Inc.
3. Globe Electric, Inc.

2.2 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.3 LUMINAIRES

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

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

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

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.4 EMERGENCY LIGHTING UNITS

A. Subject to compliance, manufacturers offering products include, but are not limited to, the following:
1. Hubbell Lighting, Inc: www.hubbelllighting.com.
2. Columbia Lighting, Inc.

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:
   1. Sealed maintenance-free lead calcium unless otherwise indicated.
   2. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

G. Accessories:
   1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
   2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
   3. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.2 EXIT SIGNS

A. Manufacturers - Powered and Self-Luminous Signs: Subject to compliance, manufacturers offering products include, but are not limited to, the following:
   1. Hubbell Lighting, Inc: www.hubbelllighting.com.
   2. Columbia Lighting, Inc.

B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single or double as indicated or as required for the installed location.
   2. Directional Arrows: As indicated or as required for the installed location.

C. Self-Powered Exit Signs:
   1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
   2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
   3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
   4. Provide low-voltage disconnect to prevent battery damage from deep discharge.
   5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

2.3 ACCESSORIES

A. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
   3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
   4. Secure pendant-mounted luminaires to building structure.
   5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
   6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
   7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

F. Recessed Luminaires:
   1. Install trims tight to mounting surface with no visible light leakage.
   2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

G. Suspended Luminaires:
   1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
   2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
   3. Provide minimum of two supports for each luminaire four feet between supports.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

I. Install accessories furnished with each luminaire.

J. Bond products and metal accessories to branch circuit equipment grounding conductor.

K. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

L. Exit Signs:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

3.4 FIELD QUALITY CONTROL

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

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs and emergency lighting units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.9 ATTACHMENTS

A. Luminaire schedule located on contract drawings.

END OF SECTION

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires.

B. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 37 - Boxes.

C. Section 26 27 26 - Wiring Devices: Receptacles for installation in poles.

D. Section 26 51 00 - Interior Lighting.

1.3 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; Institute of Electrical and Electronic Engineers; 2012.

B. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; Illuminating Engineering Society; 2002 (Reaffirmed 2008).

C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.

D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

F. NECA/IESNA 501 - Recommended Practice for Installing Exterior Lighting Systems; National Electrical Contractors Association; 2006.

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

H. UL 1598 - Luminaires; Current Edition, Including All Revisions.

I. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify Engineer/Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

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

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations of lighting fixtures.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
      b. Include IES LM-79 test report upon request.

D. Samples:
   1. Provide one sample(s) of each luminaire proposed for substitution upon request.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 WARRANTY

A. See Section 01 70 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Subject to requirements, manufacturers offering products include, but are not limited, to the following:
   1. Hubbell Lighting, Inc: www.hubbelllighting.com.
   2. Columbia Lighting, Inc.

2.2 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.3 LUMINAIRES

A. Manufacturers: Subject to requirements, manufacturers offering products include, but are not limited, to the following:
   1. Cooper Lighting

2. Lithonia lighting
3. Rab lighting
4. America lighting
5. Colby lighting
6. Eureka lighting
7. Camman lighting
8. Acuity lighting.

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

C. Provide products that are listed and labeled as complying with UL 1598, where applicable.

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

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

H. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

I. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

F. Install accessories furnished with each luminaire.

G. Bond products and metal accessories to branch circuit equipment grounding conductor.

H. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

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

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer/Architect. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.6 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.9 ATTACHMENTS

A. Refer to drawings for luminaire schedule.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. J-Hooks
   2. Cable Ties
   3. Fire Stopping
   4. Conduit Sleeves
   5. Bushings

1.2 RELATED SECTIONS REQUIREMENTS

A. Section 26 05 34 - Conduit

B. Section 07 84 00 - Firestopping

C. Section 26 05 29 - Hangers and Supports for Electrical Systems

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems

E. Section 01 30 00 - Administrative Requirements: Pre-installation meeting

F. Section 01 60 00 - Product Requirements

1.3 REFERENCES

A. ASTM International:
   1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

B. National Electrical Manufacturers Association:
   1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
   2. NEMA VE 1 - Metal Cable Tray Systems.
   3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

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

1.4 SUBMITTALS

A. Section 01 60 00 - Product Requirements

B. Product Data:
   1. Provide manufacturer's standard catalog pages and data sheets for Conduits and fittings.
   2. Provide manufacturer's standard catalog pages and data sheets for J Hook hangers and all associated hardware.
   3. Provide manufacturer's standard catalog pages and data sheets for Innerducts and accessories.
   4. Provide manufacturer's standard catalog pages and data sheets for Cable ties.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual routing of conduits, J Hooks runs, and locations of supports.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 FIRE RATED PENETRATIONS

A. Description: The firestop assembly for use in through-penetration firestop systems. The assembly shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and shall match the fire rating of the wall/floor that is being penetrated. The assembly shall be classified for use in one-, two-, and three-hour rated concrete floors or walls.

B. Firestop Assembly(s) shall be in accordance with All applicable codes and Standards.

C. All Firestop Assembly(s) shall be labeled in accordance with UL F ratings and T ratings at both sides of penetration. Provide label on wall below/near the firestop assembly in a location that is easily seen.

D. FIRE RATED CONDUIT SLEEVE FITTINGS
1. Wiremold FlameStopper Series 4 inch Trade Size, Model FS4R-RED.
2. Wiremold FlameStopper Series 2 inch Trade Size, Model FS2R-RED.
3. Product Description: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL 1479 (ÅSTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4-1/2 inches (114 mm) thick reinforced lightweight or normal weight (100 to 150 pcf) (1600 to 2400 kg/cu. m). The devices shall also have been tested by Underwriters Laboratories Inc. to UL 2043 and determined to be suitable for use in air handling spaces.

2.2 J-HOOKS

A. Panduit J-Pro Cable Support System

1. Wall Mount Model JP2W-L20

2. Wall Mount with Bracket — Model JP2WP2-L20
3. Ceiling Mount — Model JP2CM-L20
4. Drop Wire and Threaded Rod Clip — Model JP2DW-L20
5. Screw-On Beam Clamps — Model JP2SBC87R-L20

B. Product Description: Saddle style cable supports / hangers. UL 2043 Listed and suitable for use in air handling spaces.
   1. Substitutions: Section 01 60 00 - Product Requirements.

2.3 CABLE TIES

A. Panduit Plenum Rated Hook and Loop Cable Ties
   1. Plenum Rated Hook & Loop Cable Ties — Model HLTP2I-X0

B. Product Description: Plenum rated re-usable and releasable cable ties with operating temperature range of between -17 Degrees F. and 122 Degrees F.
   1. Substitutions: Section 01 60 00 - Product Requirements.
   2. Note: No plastic Zip Ties are permitted.

PART 3 EXECUTION

4.1 EXISTING WORK

A. Remove exposed abandoned cable tray, J Hooks, including above accessible ceiling finishes. Remove supports. Cut cable tray flush with walls and floors. Patch surfaces.

B. Maintain access to existing cable tray and other installations remaining active and requiring access. Modify installation or provide access panel.

4.2 INSTALLATION

A. Install supports to maintain spacing between supports of 5 ft maximum.

B. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing through fire-rated elements.

C. Install cable types in separate open cable hanger segment. Do not mix coaxial, optical fiber cable or any other cable type in the same support. If cables have more than 6” of sag, install more J-Hooks. At no point shall cable(s) rest on acoustic ceiling grids or panels.

D. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any pathway.

E. Cable pathways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular type.

F. Pathways deemed overfilled upon installation will not be accepted and shall be remedied at Contractor expense.

END OF SECTION

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates
   2. Labels
   3. Wire markers
   4. Conduit markers

B. Related Sections:
   1. Section 27 15 23 Communications Optical Fiber Cabling
   2. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 REFERENCES

A. TIA/EIA-606-A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

1.3 SUBMITTALS

A. Labeling Plan
   1. Component List: List manufacturer, part number of each label to be used.
   2. Submit labeling plan for review and approval prior to commencing labeling.

B. Product data
   1. Manufacturer and part numbers of products to be used.

PART 2 PRODUCTS

2.1 LABELS

A. Description: Labels: Embossed adhesive tape, with 3/16 inch black letters on white background.

B. Manufacturer: Panduit

1. Cat6/6A Cables	Model S050X150YAJ
2. Fiber Cables	Model NWSLC-2Y
3. Patch Panels	Model UILS7BW
6. Data Outlets	Model C195X040Y1J

2.2 CONDUIT AND RACEWAY MARKERS

A. Manufacturer: Panduit

1. Fiber Cable & Innerduct Label	Model PCV-FORY

2.3 Substitutions: section 01 60 00 - product requirements in accordance with TIA/EIA-606-A standards.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Follow manufacturer's requirements for preparation.

C. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Follow manufacturer's requirements for installation.

B. Contractor shall install identification on all of the following:
   1. Data Outlets and connectors at each end.
   2. Fiber Cabling at each end.
   3. Fiber connectors at each end
   4. Fiber Patch Panels

C. Labeling Nomenclature
   1. Data Outlets (any faceplate or surface mount box containing cat-6 data jacks)
      a. Data outlet labels to indicate TR-RK-PP-PRT where:
         1) TR = 2-digit number of Telecommunications Room
         2) RK = 2-digit number of Rack
         3) PP = 2-digit number of Patch-Panel
         4) PRT = 2-digit number port designation of patch-panel
   2. Fiber Cabling
      a. Per Standard.
   3. Fiber connectors
      a. Per Standard.
   4. Fiber Patch Panels
      a. Per Standard.

D. Install identifying devices after completion of painting.

E. Label Installation:
   1. Install label parallel to equipment lines.
   2. Install label for identification of individual control device stations

F. Wire Marker Installation:
   1. Install wire marker for each conductor at pull boxes and outlet and junction
   2. Mark data cabling within 2 inches from each end. Install additional marking at accessible locations along the cable run.
   3. Install labels at data outlets identifying patch panel and port designation as indicated on Drawings.

END OF SECTION

SECTION 27 10 05

COMMUNICATIONS COPPER CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Communications system design requirements.

B. Communications identification.

C. Cabling inside building(s).

D. Jack modules

E. Faceplates

F. Outlets

G. Surface mount boxes

H. Patch cables

I. Patch panels & strain relief bars

1.2 RELATED REQUIREMENTS

A. Section 27 05 26 - Grounding and Bonding for Communications Systems.

B. Section 26 05 37 - Boxes.

C. Section 27 05 53 - Identification for Communications Systems.

D. Section 27 15 55 - Communications Cable Testing.

1.3 REFERENCE STANDARDS

A. ANSI / NECA BICSI 568 - Telecommunications Distribution Methods Manual

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air Handling Spaces.

C. Telecommunications Industry Association / Electrical Industries Alliance:
   1. TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2012).
   2. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2014).
   3. TIA-569-C - Telecommunications Pathways and Spaces; Telecommunications Industry Association; Rev C, 2012 (with Addenda; 2013).
   4. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Telecommunications Industry Association; Rev B, 2012 (with Addenda; 2013).
   5. ANSI/J-STD-607B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
   6. UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
   1. Performance test reports showing compliance with minimum specifications.
   2. Manufacturers installation instructions.
   3. Storage and handling requirements and recommendations.
   4. Part numbers.
   5. Notes to clarify any part number choices on product sheet.
   6. Installation methods.

C. Certification:
   1. Submit current Manufacturers' Certified Installer document.

D. Evidence of qualifications for installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.6 QUALITY ASSURANCE

A. Cabling System Warranty
   1. Provide Cable Products Warranty with a complete warranty to guarantee high performance cabling systems that meet application requirements. The guarantee shall include all cable installed in the structured cabling system. The Cable shall be warranted for a period of a minimum of 20 years.

B. System Warranty
   1. A Certification / System Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include all copper connectivity components. The system shall be warranted for a period of a minimum of 20 years.

C. Product Guarantee
   1. All Manufacturers' non-consumable products must have a 25-year guarantee. When installed per TIA or ISO/IEC standards, the installed Network Cabling System will operate the application(s) for which the system was designed to support.

D. Installer Qualifications:
   1. Company specializing in installing products specified in this section with minimum three years documented experience, and with service facilities within 120 miles of project. The contractor must be approved by the manufacturer for cabling solutions – a qualified BICSI trained installer who also is certified to install the solution able to be warrantied by the Manufacturer. A current copy of the Manufacturers' Certified Installer document must be submitted.
   2. The contractor is responsible for workmanship and installation practices in accordance with the Manufacturer's Certified Program. Manufacturer shall extend a 20-year Static, Dynamic and Applications Warranty to the end user once the contractor fulfills all requirements under the Manufacturer's Certified Program. At least 30 percent of the installation and termination crew must be certified by Manufacturer with a Technicians Level of Training.
   3. Note: All Networks shall be installed per applicable standards and manufacturer's requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep stored products clean and dry.

1.8 WARRANTY

A. Provide Warranty per Section 1.6.

B. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

C. Correct defective Work within a six month period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 CATEGORY 6 UNSHIELDED HORIZONTAL CABLE (PLENUM RATED)

A. Manufacturers:

1.	Panduit CAT-6 Cable	Model - PUP6004BU-UY
2.	Belden CAT-6 Cable	Model - 3613 D15U1000
3.	Berk-Tek CAT-6 Cable Lanmark-1000	Model - 10032094

B. Color:

1.	General Use Data	White

C. Product Description: Enhanced Category 6 TIA/EIA 568-B.2-1, 100-ohm, unshielded twisted pair plenum rated cable with 4 pairs, 23 AWG copper conductors.

D. Additional Installation notes: Any cable installed by the contractor exceeding 90 meters (295 feet) long must be replaced and routed to reduce length to 90 meters or less. Complete all cable re-routing at no additional cost to Owner. Identify in writing to Architect / Engineer prior to installation of any cables that cannot be reduced to 90 meters or less in length.

2.2 DATA JACKS

A. CAT6 - Panduit Mini-Com TX6 PLUS Model CJ688TG**

B. Color:

1.	General Use Data	White

C. Wiring Scheme: T568B

D. Product Description: RJ45, 8-position, 8-wire universal module. Contacts plated with 50 micro inches of gold. Compatible with Mini-Com Modular Patch Panels, Faceplates, and Surface Mount Boxes.

2.3 PATCH CABLES

A. Panduit Patch Cables (for Data Room End - 1 Per Data drop) Model UTPSP[x]**Y

B. Lengths:

1.	Data room end Locations with Data Cabinets	3 foot	([x] = 3)

C. Color:

1.	General Use Data	White

D. Product Description: Category 6, 24 AWG UTP patch cords with TX6 PLUS Modular Plugs on each end. Exceed ANSI/TIA-568-C.2 Category 6 and ISO 11801 Class E Standards.

E. Additional Installation notes:
   1. Contractor to establish proper wire management for patch cables from patch panels to switches. “Spider Webbing” with patch cables will not be accepted.
   2. Patch cables shall not be shorter than 36".

2.4 DATA FACEPLATES

A. Panduit Mini-Com Classic Series
   1. Two Module Model UICFP2IW

B. Provide Blank Modules for all unused module spaces. Model CMBIW-X

2.5 DATA OUTLET BOXES

A. Panduit Mini-Com Surface Mount Box Model CBXJ2IW-A

B. Mounting:
   1. Panduit magnets to mount Surface Mount Boxes to structural steel or other permanent metal surface where possible. Model CBM-X
   2. Hook and Loop Cable ties may be used to mount Surface Mount Boxes where magnets cannot be used.

C. Product Description: Surface mount box accepts one or two Panduit Mini-Com Modules.

2.6 SUBSTITUTIONS

A. Section 01 60 00 - Product Requirements.

2.7 SYSTEM DESIGN

A. Provide a complete permanent end to end system of cabling and pathways for data communications, including but not limited to cables, conduits and wireways, pull wires, support structures, support devices, racks and cabinets, outlets, , and patch cables. Use existing patch panels
   1. Comply with TIA-568 (cabling) and TIA-569 (pathways), latest editions (commercial standards).
   2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
   3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA/EIA-568-C-1, TIA/EIA-569, ANSI/J-STD-607-B, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Comply with latest editions and addenda of ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

C. Comply with Communication Service Provider requirements.

D. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.2 INSTALLATION OF EQUIPMENT AND CABLING

A. The contractor is responsible for workmanship and installation practices in accordance with the Manufacturer's Certified Program. Manufacturer shall extend a minimum 20-year Static, Dynamic and Applications Warranty to the end user once the contractor fulfills all requirements under the Manufacturer's Certified Program. At least 30 percent of the installation and termination crew must be certified by Manufacturer with a Technicians Level of Training.

B. Note: All Networks shall be installed per applicable standards and manufacturer's requirements.

C. Copper Cabling:
1. Use only type CMP plenum-rated cable.
2. Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
3. Do not exceed 25 pounds pull tension.
4. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
5. Do not pre pull cable out of box / reel prior to installing.
6. Do not over-cinch or crush cables.
7. Do not exceed manufacturer's recommended cable pull tension.
8. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
9. Protect from paint and other damaging contaminants. (any painted / contaminated cables shall be replaced at contractor's expense).

D. Identification:
1. Use wire and cable markers to identify cables at each end.

3.3 FIELD QUALITY CONTROL

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

B. Comply with inspection and testing requirements of specified installation standards.

C. Visual Inspection:
1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.
3. Inspect outlet plates and patch panels for complete labels.

D. Testing per specifications.

E. Labeling per specifications.

F. Comply with all manufacturers installation, warranty, and handling requirements.

END OF SECTION

SECTION 27 15 23

COMMUNICATIONS OPTICAL FIBER CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fiber Optic Cabling inside building(s).

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Electrical system grounding and bonding.

C. Section 26 05 37 - Boxes.

1.3 REFERENCE STANDARDS

A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.

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

C. TIA-492AAAA-B - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.

D. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.

E. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).

F. TIA-526-7 - OFSTP-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; 2002.

G. TIA-526-14 - OFSTP-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Rev B, 2010.

H. TIA/EIA-568-C.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev C, 2012; Addenda 1-7.

I. TIA/EIA-568-C.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables

J. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; 2012.

K. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.

2. Installation methods.

C. Manufacturer Qualifications.

D. Installer Qualifications.

E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

F. Field Test Reports.

G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. Record actual locations of outlet boxes and distribution frames.
2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify distribution frames and equipment rooms by room number on contract drawings.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.

B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
1. Employing experienced technicians for all work; show at least 3 years experience in the installation of the type of system specified, with evidence from at least 2 projects that have been in use for at least 18 months; submit project name, address, and written certification by user.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep stored products clean and dry.

1.7 WARRANTY

A. See Section 01 70 00 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cabling and Equipment:
1. Corning Cable Systems OS2 Single-Mode Fiber: Model: 012E88-33131-D3

B. LC Single-Mode Connectors
1. CORNING Unicam LC Single-Mode Connector Model 95-200-99

C. Patch Cables
1. SC to LC duplex fiber patch cables
a. Corning Cable Systems OS2 Single-Mode Fiber 6 meter Part# 047202R5Z20006M
2. LC to LC duplex fiber patch cables.

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
   2. Comply with TIA-570, latest edition.
   3. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
   4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.

2.3 PATHWAYS

2.4 FIBER OPTIC CABLE AND ADAPTORS

A. Fiber Optic Backbone Cable: 24-fiber, multimode 50/125 um, complying with TIA-492AAAB; covered with orange cable jacket and complying with relevant portions of and addenda to latest edition of TIA/EIA-568.
   1. In locations other than in plenums, provide NFPA 70 type OFNR nonconductive-riser-rated or type OFNP nonconductive-plenum-rated cable.
   2. In plenums, provide NFPA 70 type OFNP nonconductive-plenum-rated cable.
   3. Testing: Furnish factory reel tests.

B. Fiber Optic Horizontal Cable: Two-fiber, multimode 50/125 um, complying with TIA-492AAAB; covered with orange single jacket and complying with relevant portions of and addenda to latest edition of TIA/EIA-568.
   1. In locations other than in plenums, provide NFPA 70 type OFN nonconductive general purpose, OFNR nonconductive-riser-rated, or type OFNP nonconductive-plenum-rated cable.
   2. In plenums, provide NFPA 70 type OFNP nonconductive-plenum-rated cable.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA/EIA-568, TIA/EIA-569, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Comply with latest editions and addenda of TIA-570, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.2 PATHWAYS

A. Install with the following minimum clearances:
   1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
   2. 12 inches from power conduits and cables and panelboards.
   3. 5 inches from fluorescent and high frequency lighting fixtures.
   4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit:
   1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
   2. Leave pull cords in place where cables are not initially installed.
   3. Conceal conduit within finished walls, ceilings, and floors except where specifically indicated to be exposed.

a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.

C. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.

D. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 07 84 00.

3.3 INSTALLATION OF CABLING

A. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
2. At Outlets - Optical Fiber: 40 inches.

B. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
2. Support vertical cable at intervals as recommended by manufacturer.

C. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
1. Cables: Install color coded labels on both ends.
2. Outlets: Label each jack on its face plate as to its type and function, with a unique numerical identifier.
3. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.
4. Patch Cords: Label with jack identifier corresponding to initial installation.

3.4 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

B. Visual Inspection:
1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.
3. Inspect outlet plates and patch panels for complete labels.
4. Inspect patch cords for complete labels.

END OF SECTION

SECTION 27 15 55
COMMUNICATIONS CABLE TESTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provide all labor, materials, tools, equipment, and field-test instruments required for the complete testing, identification and administration of the work called for in the Contract Documents.

B. To conform to the overall project schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.

C. Minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
   1. Multimode Fiber Cabling

1.2 RELATED REQUIREMENTS

A. Section 27 15 23 - Communications Optical Fiber Cabling

1.3 REFERENCE STANDARDS

A. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 2012.

B. TIA-492AAAA-B - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.

C. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.

D. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).

E. TIA/EIA-568-C.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev C, 2012; Addenda 1-7.

F. TIA/EIA-568-C.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev C, 2012; Addenda 1-11.

G. TIA/EIA-568-C.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables

H. ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR.

I. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.

J. ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR.

K. ANSI Z136.2, ANS for Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources.

L. ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements

M. ANSI/TIA 526 14 B, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fiber Optic Communications Subsystem Test Procedure- Part 4-1: Installed cable plant- Multimode attenuation measurement.

N. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.

1.4 SUBMITTALS

A. Manufacturers catalog sheets and specifications for fiber optic and copper field-test instruments.

B. Sample test reports.

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

1.5 QUALITY ASSURANCE

A. Installer / Tester Qualifications:
   1. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi or the ACP (Association of Cabling Professionals).
      a. Manufacturer of the copper cable and copper connectors, manufacturer of the fiber optic cable and/or the fiber optic connectors.
      b. Manufacturer of the test equipment used for the field certification.

B. Testing Equipment Qualifications:
   1. Field test instruments shall comply with the accuracy requirements for level III field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 3 of ANSI/TIA-1152 (Table 3 in this TIA document also specifies the accuracy requirements for the Channel configuration).
   2. Field-test instruments shall have the latest software and firmware installed.
   3. Field-test instruments (tester) shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
   4. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
   5. Testing of the fiber cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.
   6. The copper tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
   7. Field-test instruments (tester) shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
   8. Field-test instruments shall have the latest software and firmware installed.

PART 2 EXECUTION

2.1 FIBER

A. Every fiber cable link shall be tested in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end faces shall also be verified.

B. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

C. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

D. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

E. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.

F. Fiber end faces shall be inspected at x200 or x400 magnification. x200 magnification is suitable for inspecting multimode and singlemode fibers. x400 magnification may be used for detailed examination of singlemode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
   1. It is preferable that the end face images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.

G. Testing shall be performed on each cabling segment (connector to connector).

H. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.

I. Optical loss testing - Horizontal / Backbone link
   1. Multimode links shall be tested at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14-B, one-cord reference method.
   2. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

J. OTDR Testing
   1. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      a. Multimode: 850 nm and 1300 nm
   2. Each fiber link and channel shall be tested in both directions.
   3. A launch cable shall be installed between the OTDR and the first link connection.
   4. A receive cable shall be installed after the last link connection.

K. Magnified End Face Inspection
   1. Fibers shall be inspected at x250 or x400 magnification. x250 magnification is suitable for inspecting multimode and singlemode fibers. x400 magnification may be used for detailed examination of singlemode fibers.

L. Length Measurement
   1. The length of each fiber shall be recorded.
   2. It is preferable that the optical length be measured using an OLTS or OTDR.

M. Polarity Testing
   1. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA 568 C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

2.2 DOCUMENTATION

A. The test results/measurements saved within the field test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. A guarantee shall be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the field test instrument” at the end of each test and that these results cannot be modified at a later time. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.

B. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.

C. The database for the completed job shall be stored and delivered on CD-ROM or DVD prior to Owner acceptance. This CD-ROM or DVD shall include the software tools required to view, inspect, and print any selection of test reports.

D. Circuit IDs reported by the test instrument should match the specified label ID.

E. Detailed test result documentation shall be provided in an electronic data base and shall include the following information for each link:
   1. Identification of the customer site as specified by the owner.
   2. Identification of the link in accordance with the naming convention defined in the overall system documentation.
   3. The name of the test limit selected to execute the stored test results.
   4. The name of the personnel performing the test.
   5. The overall Pass/Fail evaluation of the link-under-test.
      a. Including the NEXT Headroom (overall worst case) number for copper.
      b. Including OLTS and OTDR measurements for fiber.
   6. Identification of the tester interface.
   7. Date and time the test results were saved in the memory of the tester.
   8. The manufacturer, model and serial number of the field-test instrument.
   9. The version of the test software and the version of the test limit database held within the test instrument
   10. Test results information must contain information on each of the required test parameters that are listed in this Section and as further detailed below.

F. Fiber
   1. Detailed test results data to be provided in the electronic database for must contain the following information:
      a. The fiber identification number.
      b. The length for each optical fiber.
      c. The length for each optical fiber as calculated by the OTDR.
      d. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
      e. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).

2.3 FIELD QUALITY CONTROL

A. A representative of the owner shall reserve the right to be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.

B. A representative of the owner shall reserve the right to select a random sample of 5% of the installed links. The representative (or his / her authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in this Section. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

END OF SECTION

SECTION 28 31 00
ADDRESSABLE FIRE ALARM SYSTEM

GENERAL

1.1 DESCRIPTION OF WORK:

A. Provide complete new fully functioning Fire Alarm System in it's entirety inclusive of all required wiring, conduit, peripherals, digital communicators, power supplies, modules, annunciators, and controls.
   1. Upon installation and final acceptance of new fire alarm system; disconnect and remove all previously existing fire alarm systems in their entirety. Remove and legally dispose of all associated devices, circuitry, controls, and associated components.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:
   1. This specification describes an addressable Fire Detection and alarm signaling system. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor.
   2. The system shall be in full compliance with National and Local Codes.
   3. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
   4. All equipment furnished shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years.
   5. The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
   6. In the interest of job coordination and responsibilities the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests, and shall be capable of providing a “UL Listing Certificate” for the complete system.
   7. The system specified shall be that which meets the project requirements. Other systems shall be submitted 10 days prior to bid date for approval by the Engineer. All system approved shall meet all the requirements spelled out in this specification. System approval shall be in writing by the Engineer and a copy shall be submitted with the system submittals.

1.4 SYSTEM DESCRIPTION

A. The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor based operating system having the following capabilities, features, and capacities:
   1. Support of mobile test system capable of providing point test reports in NFPA standard format without manual report entries.

2. System shall provide an output port for monitoring purposes by external systems. Communications to an external system shall be RS-232 or RS-485 communications.
3. Up to 16 nodes shall be networkable in a peer-to-peer configuration.
4. Communications between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide display. Any network node shall be capable of supporting a local system with the same capacities and features specified herein.
5. The local system shall provide status indicators and control switches for all of the following functions:
   a. Audible and visual notification alarm circuit zone control.
   b. Status indicators for sprinkler system water-flow and valve supervisory devices.
   c. Any additional status or control functions as indicated on the drawings, including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with NFPA 72 and all contract documents and specification requirements.

B. All interconnections between this system and the monitoring system shall be arranged so that the entire system can be UL-Certificated.

C. The system shall Include voice alarm communication including microphones,

D. System shall be a complete, supervised, non-coded, addressable multiplex fire alarm system conforming to NFPA 72.

E. The system shall have Style 4 circuits for each floor. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal.

F. The system shall be capable of the following configurations. Both configurations are permitted on the same network.
   1. The system shall support up to 252 addressable devices, which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.
   2. The system shall support two loops of 252 addressable devices, each of which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.

G. The system shall have a built-in digital alarm communication transmitter.

H. The system shall provide an off-normal warning prior to reset for all active devices.

I. The system shall be capable of remote monitoring via a proprietary software system that provides a graphical representation of the fire alarm control panel at a remote PC when connected via Ethernet to the system. The display will show the exact state of the panel, including blinking LEDs, and with menu buttons for control.

J. The system shall be capable of being configured either at the control panel or via a PC Tool.

K. In networked systems, each control panel shall be a global annunciator, capable of viewing all other control panels on the network.

L. The system shall provide the following functions and operating features:
   1. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
   2. Provide Class B initiating device circuits.
   3. Provide Style 7 signaling line circuits for the network.

4. Provide two Class B notification appliance circuits. Arrange circuits to allow individual, selective, and visual notification by zone. Notification appliance circuits shall be zoned to correspond with the building fire barriers and other building features.
5. Strobes shall be synchronized throughout the entire building.
6. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

M. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals, trouble signals shall be logged on the system printer and in system history during the walk-test.

N. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

O. Fire alarm signal initiation shall be by one or more of the following devices:
1. Manual pull station
2. Heat detector
3. Addressable area smoke detectors
4. Addressable Multi-criteria smoke detectors with built-in Carbon Monoxide detector
5. Standard Addressable Duct smoke detector with remote test switch

P. Activation of any system fire, security, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network Person Machine Interfaces using basic graphics and multiple detail screens.
1. Fire Alarm Condition:
   a. Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm in a graphic display.
   b. Log into the system history archives all activity pertaining to the alarm condition.
   c. Print alarm condition on system printer.
   d. Sound the ANSI 117-1 signal with synchronized audible notification appliances and synchronized strobes throughout the facility.
   e. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or alarm silencing, as required.
   f. A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.
   g. Activation of any smoke detector in a single elevator lobby or an elevator equipment room shall, in addition to the actions described, cause the recall of that bank of elevators to the 1st floor and the lockout of controls. In the event of recall initiation by a detector in the first floor lobby, the recall shall be to the alternate floor as determined by the AHJ.
   h. Where indicated on drawings heat detectors in elevator shaft and machine rooms shall activate an elevator power shunt trip breaker. The heat detectors shall be rated at a temperature below the ratings of the sprinkler heads in respective locations to insure that the power shall be shut off before activation of sprinkler system.
   i. System operated duct detectors as per local requirements shall accomplish HVAC shut down.
   j. Door closure devices shall operate by floor or by local requirements.
   k. Fire alarm signal to be sent to central station service.
2. Carbon Monoxide Condition:
   a. Sound a distinctive localized alarm from the actual detection device and display a location of event at the addressable fire alarm panel and at the remote annunciators.
   b. Notify personnel in an approved continuously attended supervisory station. Personnel shall then contact the responsible party in accordance with the notification plan per NFPA 720.

3. Supervisory Condition:
    a. Display the origin of the supervisory condition report at the local fire alarm control panel graphic LCD display.
    b. Activate supervisory audible and dedicated visual signal.
    c. Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.
    d. Record within system history the initiating device and time of occurrence of the event.
    e. Print supervisory condition to system printer.
    f. Supervisory signal to be sent to central station service
4. Trouble Condition
    a. Display at the local fire alarm control panel graphic LCD display, the origin of the trouble condition report.
    b. Activate trouble audible and visual signals at the control panel and as indicated on the drawings.
    c. Audible signals shall be silenced from the fire alarm control panel by a trouble acknowledge switch.
    d. Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.
    e. Trouble reports for primary system power failure to the master control shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.
    f. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.
    g. Print trouble condition to system printer.
    h. Trouble signal to be sent to central station service.

Q. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, and finish and mounting requirements.

B. Power calculations. Battery capacity calculations. Battery size shall be a minimum of 125% of the calculated requirement. Provide the following supporting information:
1. Supervisory power requirements for all equipment.
2. Alarm power requirements for all equipment.
3. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
4. Voltage drop calculations for wiring runs demonstrating worst-case condition.
5. NAC circuit design shall incorporate a 15% spare capacity for future expansion.

C. Submit manufacturer's requirements for testing Signaling Line Circuits and device addresses prior to connecting to control panel. At a minimum the following tests shall be required; device address, the usage (Alarm, Supervisory etc), environmental compensation, temperature ratings for thermal detectors and smoke detector sensitivities. This requirement shall need approval before any wiring is connected to the control panel.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Complete drawings covering the following shall be submitted by the contractor for the proposed system:
    a. Floor plans in a CAD compatible format at a scale of 1/8”=1’-0” showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used.
    b. Provide a fire alarm system function matrix as referenced by NFPA 72, Figure A-7-5.2.2 (9). Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at time of bid.
4. Installation drawings shop drawings, and as-built drawings shall be prepared by an individual experienced with the work specified herein.
5. Incomplete submittals shall be returned without review, unless with prior approval of the Engineer.

E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Light fixtures.
2. HVAC registers
3. Fire protection equipment interfaces
4. Special suppression system interfaces

F. Qualification Data: For qualified Installer, Applicator, manufacturer, fabricator, professional engineer, testing agency, and factory-authorized service representative.

G. Source quality-control reports.

H. Field quality-control reports.

I. Operation and Maintenance Data: For all fire alarm equipment, to include in operation and maintenance manuals.

J. 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.

K. Warranty: Sample of special warranty.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.
1. FM Global (Factory Mutual (FM)):FM Approval Guide
2. National Fire Protection Association (NFPA)
    a. NFPA 70 National Electrical Code
    b. NFPA 72 National Fire Alarm Code
    c. NFPA 90A Standard For The Installation of Air Conditioning and Ventilating Systems
    d. NFPA 101 Life Safety Code

e. NFPA 720 Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment

3. Underwriters' Laboratories, Inc. (UL) equipment standards, Latest Edition
   a. UL Fire Protection Equipment Directory
   b. UL Electrical Construction Materials Directory
   c. UL 38 – Manually Actuated Signaling Boxes for Use With Fire Protection Signaling Systems
   d. UL 228 – Door Holding Devices
   e. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
   f. UL 268A - Smoke Detectors for Duct Application
   g. UL 464 - Audible Signal Appliances
   h. UL 497A – Secondary Protectors for Communications Circuits
   i. UL 521 - Heat Detectors for Fire Protective Signaling Systems
   j. UL 864 - Control Units for Fire Protective Signaling Systems
   k. UL 1283 – Electromagnetic Interference Filters
   l. UL 1449 - Transient Voltage Surge Suppressors
   m. UL 1971 - Signaling Devices for the Hearing Impaired
   n. UL 2075 – Gas and Vapor Detectors and Sensors
   o. UL 1480 - Speaker notification appliances
4. NY-MEA
5. ISO 9002

B. Supplier Qualifications
   1. The manufacturer of the supplied products must utilize multi-channel product distribution on a national basis to be considered for this bid. The manufacturer must have factory branches as well as independent distributors to allow the end user with the ability to utilize factory trained and authorized competitive service providers after system installation and commissioning.
   2. Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required by law.
   3. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
   4. The suppliers shall furnish evidence they have an experienced service organization, which carries a stock of spare and repair parts for the system being furnished.
   5. The equipment supplier shall be authorized and trained by the manufacturer to calculate, design, install, test, and maintain the air sampling system and shall be able to produce a certificate stating such upon request.

C. Installer Qualifications:
   1. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
   2. The contractor shall submit copies of all required Licenses and Bonds as required in the State having jurisdiction.
   3. The contractor shall employ on staff a minimum of one NICET level II technician or a professional engineer, registered in the State of the installation.
   4. The contractor shall be qualified by UL for certifying fire alarm systems.
   5. Contractors unable to comply with the provisions of Qualification of Installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.

D. Source Limitations for fire alarm equipment: Obtain fire alarm equipment from single source.

E. 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.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
   3. Combustion Characteristics: ASTM E 136.

F. 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.

G. Pre-installation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.

B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.9 PROJECT CONDITIONS

A. Installed products or materials shall be free from any damage including, but not limited to, physical insult, dirt and debris, moisture, and mold damage.

B. Environmental Limitations: Do not deliver or install products or materials until spaces are enclosed and weather-tight, 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.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire alarm equipment that fail(s) in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year from date of Substantial Completion.

1.11 SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for 1 year.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Seimens Indrustry, Building Technologies Division, (or approved equal).

2.2 CONTROL PANEL

A. The fire alarm control panel shall be microprocessor based using multiple microprocessors throughout the system providing rapid processing of smoke detector and other initiation device information to control system output functions.

B. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal, and reset the panel.

C. The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage

D. The system shall be capable of the following configurations. Both configurations are permitted on the same network.
   1. The system shall support two loops of 252 addressable devices, each of which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.

E. The system shall be capable of supporting unshielded wiring applications.

F. The system shall be compliant with the requirements of NFPA 720 as a Carbon Monoxide Detection Control Unit and shall meet the UL 2075 listing requirements. All inputs from CO sensors shall be indicated visually and audibly at the control panel. CO sensor inputs shall be distinct and descriptively annunciated from other signals.

G. System Components:
   1. The System Periphery board shall be capable of 252 intelligent devices distributed between one, two, three, or four Class B SLC circuits. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on board microprocessor provides the periphery board with the ability to function even if the main microprocessor fails. LED's on the board shall provide annunciation for the following; Power, Gnd. Fault, Alarm, Trouble. This board is integral to the system.
   2. The system periphery board shall be capable of supporting two system drivers of 252 intelligent devices distributed between one, two, three, or four Class B SLC circuits, for a total panel capacity of 504 addressable devices. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on board microprocessor provides the periphery board with the ability to function even if the main microprocessor fails. LED's on the board shall provide annunciation for the following: Power, Gnd. Fault, Alarm, Trouble. This board is integral to the system.
   3. The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage short term or long term to the control panel. After initial testing replace the test panel and proceed with complete testing.
   4. The standard Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked control panels, when configured as a global PMI.
   5. The LED Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked control panels, when configured as a global PMI. Additionally, the operator interface provides twelve multicolored configurable LEDs for annunciating system status.
   6. The Network Card shall provide internode communication between enclosures. Communication shall support Class B Style 4 or Class A Style 7 wiring (in a ring configuration). This card shall plug into the system operator interface.

7. The System Periphery Board shall contain 2 Class B NAC circuits rated at 3 amps each with power-limited outputs. The zones shall be isolated and independently supervised. There shall be at least 6 unique codes/signals for each circuit based on system logic. These signals shall be Temporal Code 3 (Evacuation), Steady (Such as “Recall”), Temporal Code 4 (for CO alarms), March Time 120ppm, March Time 60ppm, and March Time 30ppm. The card shall have the following LED’s to provide trouble shooting and annunciation; Power, Gnd. Fault, Zone Activation or Trouble. This functionality shall be integral to the system.
8. The control panel shall be equipped with four Form C relays for alarm, trouble, supervisory, and programmable output. The system shall provide the mounting of all system cards, field wiring, and panel’s inter-card wiring. All power limited field wiring shall be separated from all non-power limited internal wiring.

H. System response time from alarm to output shall be an average of three (3) seconds.

I. All system cards and modules shall have Flash memory for downloading the latest module firmware.

J. Passwords:
   1. Technician Level Password - There shall be a 5 character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions at the panel as:
      a. Arming and disarming devices.
      b. Activating, deactivating or modifying detector ASD and sensitivity settings.
      c. Activating and deactivating the History Log function, and deleting obsolete entries.
      d. Changing the system time and date.
   2. Maintenance Level Password - There shall be a 5 character password that a user must enter into the control panel in order to access the panel's reporting functions and walktest functions.
   3. Acknowledge Silenceable Reset Access - There shall be a key required to open a locked cabinet that a system user must use in order to acknowledge events, turn silenceable audibles and visuals on and off, and perform panel resets.

K. Networking:
   1. Digital communication capabilities supporting Style 4 (Class B) or Style 7 (Class A) communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with up to 16 FACPs.
   2. Digital communication capabilities supporting Style 4 (Class B) or Style 7 (Class A) communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with up to 4 network nodes.
   3. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications.
   4. Communication protocol shall be of the RS485 type.

L. Network Fiber Modules
   1. Multimode and single mode.
   2. The network fiber interface modules shall be used to transmit RS-485 communications between intelligent addressable fire alarm control panels. Each module shall have power, transmit and receive status LEDs. The module can act as a repeater or end-point unit, in a daisy chain or star configuration.
   3. The connection between the multimode fiber interface modules shall use 2 high quality duplex 50/125 or 62.5/125 fiber optic cables and ST style fiber connectors. Each segment of the fiber network can be up to 1.9 miles. The fiber module shall have a minimum operating power output budget of -13dB for 62.5/125 cable and -9 dB for 50/125 cable.

4. The connection between the single mode fiber interface modules shall use 2 high quality duplex 9/125 fiber optic cables and ST style fiber connectors. Each segment of the fiber network can be up to 20 miles. The fiber module shall have a minimum operating power output budget of -16dB for 9/125 cable.

M. Degrade Mode Alarm Activation:
1. Each panel shall operate as a stand-alone fire alarm control panel with complete functionality in the event of loss of communications with other panels on a network.

N. Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.

O. History: The system shall store 20000 events in history. Trouble warnings will occur when the History buffer is full.

P. Reports:
1. The system shall have the ability to provide configuration, status, queue and history reports.
2. Configuration reports shall provide the following information:
   a. Custom Messages
   b. Database Information
   c. Entity Type
   d. Device Usage
   e. Zone usage
   f. Device Category
   g. Firmware revision
3. Status reports shall provide the following information:
   a. Disarmed cards and devices
   b. ASD settings
   c. Sensitivity in %/foot
   d. Alarm threshold in %/foot
   e. Temperature in degrees C
   f. Walktest
4. Queue reports shall provide the following information:
   a. Alarm events with custom message and event time
   b. Gas alarm events with custom message and event time
   c. Supervisory events with custom message and event time
   d. Trouble events with custom message and event time
   e. Status events with custom message and event time
   f. Information events
5. History reports shall provide Address, History Type, Description, Time & Date and Custom Message. The following event types shall be reported:
   a. Alarm events
   b. Gas alarm events
   c. Supervisory events
   d. Status changes
   e. Alarm verification
   f. Output activation from logic
   g. System Reset
   h. Event Acknowledgements
   i. Block Acknowledgements
   j. Audible Silence System Flag Changes
   k. Sensitivity Changes
   l. Arm / Disarm Commands

m. Arm / Disarm By Logic
n. Manual Output Overrides
o. Output Overrides By Logic
p. Time Changes
q. Menu Logins
r. ASD Changes
s. Walktest
t. Device Input to Logic Activations/Deactivations

2.3 POWER SUPPLY

A. The system Power Supply shall be filtered and regulated. The power supply provides power for all system operation, including signaling line circuits, notification appliance circuits, auxiliary power, battery charger, and all optional modules. The power supply shall be rated for 120/240 VAC 50/60 Hz.

B. The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with a special software package to select charging rates and battery sizes. An optional Thermistor for monitoring battery temperature to control charging rate shall be available.

C. Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation.

2.4 BATTERIES

A. Batteries shall be of sufficient capacity to provide power for the entire system upon loss of normal AC power for a period of 24 hours with five (5) minutes of alarm signal at the end this 24-hour period, as required by NFPA 72, Local Systems.

B. CARBON MONOXIDE DETECTION SYSTEM: Batteries shall be dedicated to the Carbon Monoxide Detection System as required by NFPA 720, Secondary Power Supply.

2.5 SYSTEM ENCLOSURE

A. Provide the enclosure needed to hold all the cards and modules as specified with at least spare capacity for two cards. The outer doors shall be capable of being a left hand open. The inner door shall have a left hand opening.

B. Outer Door shall have integral cylinder lock and latch.

2.6 INTELLIGENT INITIATING DEVICES

A. General
1. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections.

B. Smoke Detectors – Standard Addressable
1. The detector shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detector must provide up to 11 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
2. The detector shall have a multicolor LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.

3. The multi-criteria smoke detector shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of eleven environmental fire profiles unique to the devices installed location.
4. The detector shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
5. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
6. The detector shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
7. For the detector where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
8. Where required, there shall be available a programmable remote lamp configurable to remotely duplicate the on-board LED status of another system device with the same software address.

C. Heat Detectors – Addressable
1. Thermal Detectors shall be rated at 135 degrees fixed temperature and 15 degrees per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.
2. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.
3. Heat detector shall have the following temperature settings:
   a. Fixed temperature at 135°F, 145°F, 155°F, 165°F, 174°F
   b. Rate of Rise at 15°F/ min (8.3°C) at 135°F (57°C)
   c. Rate of Rise at 15°F/ min (8.3°C) at 174°F (79°C)
   d. Low temperature warning at 40°F (4.4°C)

D. Duct Smoke Detectors – Addressable
1. For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
2. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.
3. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.

4. Where required there shall be available a duct housing with an on-board relay. Also where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel.
5. Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°F to 120°F per minute, and with relative humidity ranging from 0 to 95%.
6. Duct Housings and Accessories:
   a. Global Air Duct Housing for Conventional and Addressable Detectors
   b. Global Air Duct Housing for Addressable P2 Detectors with Relay Application
   c. Global Air Duct Housing for Conventional Detectors with Relay Application
   d. Global Air Duct Housing for Conventional Detectors with Relay Application and Built-in Power Source
   e. Weather-Proof housing to accommodate all versions of Global Air Duct Housings
   f. Remote Test Lamp for Conventional Detectors

E. Detector Bases – Addressable
1. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.
2. Detectors shall be listed per UL 268A as “direct in duct” without need for a duct housing.
3. Multi-Criteria Fire Detector shall be listed as providing CO detection in duct application.

F. Manual Pull Stations – Addressable
1. Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.
2. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
3. Provide double action pull station.
4. Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.

G. Addressable Interface Devices
1. Addressable Interface Devices shall be provided to monitor contacts for such items as water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.
2. Where needed a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 convention smoke detectors and an unlimited number of contact devices. This module shall also be capable of monitoring Linear Beam detectors and conventional Flame detectors. Where required, there shall be an intrinsically safe detection solution for NEMA defined intrinsically safe installations compatible with the conventional zone module.
3. Single Device Damper Monitoring and Control: A single switch input shall be able to monitor all 3 states of a damper – open, closed, and in transit. A single device shall be able to fully control a damper (through the relay connected to the motor control) while also using its switch input for monitoring all 3 states of the damper.
4. Addressable input/output module shall be insensitive to polarity and shall have capability for up to 4 separate inputs (Class B) or 2 separate Class A inputs and 4 separate outputs (Class B).

2.7 DEVICE PROGRAMMING UNIT

A. Device Programming Unit: The programming tool shall program the intelligent devices with addresses. The unit shall test the device to respond to its address. DIP switches and rotary switches shall not be acceptable. The programmer shall have a carrying case.

2.8 NOTIFICATION APPLIANCES

A. Strobes: Siemens True Alert, (or approved equal)
   1. The strobes shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service
   2. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B
   3. Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
   4. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by a Fire-Alarm Control Panel (FACP)
   5. The Strobe shall be of low-current design
   6. The strobe intensity shall have field-selectable settings, and shall be rated per UL Standard 1971 for 15/30/75/95cd or 115/177cd for ceiling mount where Multi-Candela appliances are specified
   7. The selector switch for selecting the candela shall be tamper resistant
   8. The appliance shall be compatible with sync modules or strobe power panel supply with built-in sync protocol when synchronization is required
   9. The strobes shall not drift out of synchronization at any time during operation
   10. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate
   11. The strobes shall be designed for indoor surface of flush mounting
   12. The Strobe Appliances shall incorporate a Patented, Integral Strobe Mounting Plate that shall allow mounting to single-gang, double-gang, 4-inch square, 100mm European type back boxes, or the surface back box
   13. The Multi-Candela or Single-Candela Strobe Plate shall mount to either a standard, 4-inch square back box for flush mounting, or shall mount to a box for surface mounting
   14. All notification appliances shall be backward compatible

B. Speaker and Speaker Strobe Appliances
   1. Speaker Strobe and standalone Speaker Appliances shall meet and be listed for UL 1480.
   2. Speaker shall operate on standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.
   3. Speaker shall have the following taps: 0.25W, 0.50W, 1.0W and 2.0W.
   4. The speaker frequency shall be 400 to 4000Hz for fire alarm and 125-12kHz for general signaling.
   5. The speaker shall install directly to a 4" square, 1-1/2" deep box with 1-1/2" extension.
   6. Strobe portion of the appliance shall produce a flash rate of one (1) flash per second over the Regulated Input Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
   7. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
      a. 15/30/75/110cd
   8. The selector switch for selecting the candela setting shall be tamper resistant
   9. The appliance, when synchronization is required, shall be compatible with sync modules or Power Supplies with built-in Sync Protocol
   10. The strobes shall not drift out of synchronization at any time during operation
   11. The strobes shall revert to a non-synchronized flash-rate, if the sync module or Power

Supply should fail to operate (i.e. – contacts remain closed)

12. All notification appliances shall listed for Special Applications:
    a. Strobes are designed to flash at 1-flash-per-second minimum over their “Regulated Input Voltage Range”
13. All candela ratings represent minimum-effective Strobe intensity, based on UL Standard 1971

2.9 DIGITAL COMMUNICATOR

A. The Multi-Point Digital Alarm Communicator shall be UL864 listed to provide point identification of alarm, supervisory, security and trouble events to a Central or Remove Receiving Station. The DACT shall support the following:
   1. Ademco Contact ID or SIA protocol
   2. Ademco Contact ID selection shall provide the ability to transmit events for up to 999 individual zones
   3. SIA selection shall provide the ability to transmit events for up to 10000 individual points
   4. Programming of accounts and phone numbers
   5. Dual phone line interface
   6. Line fault monitoring.
   7. Automatic 24-hour test
   8. The DACT supports configurable alarm, alarm restoral, trouble, trouble restoral, supervisory, supervisory restoral, and reset events.
   9. The DACT supports Ademco Contact ID alarm event codes for general alarm, smoke detector alarm, waterflow alarm, duct alarm, and manual alarm events.
   10. The DACT shall communicate to a Central or Remote Receiving Station upon a carbon monoxide detection event per NFPA 720.
   11. Optionally, the DACT can be programmed to report events by event queue only.

2.10 REMOTE ANNUNCIATOR

A. The fire-system displays are remote LCD units that show existing status of the FACP.

B. The display supports the following LED's for system-status conditions:
   1. Power
   2. Alarm
   3. Trouble
   4. Supervisory
   5. Ground-Fault

C. A 3.5 inch by 1.5 inch LED screen will give details of the event in alphanumeric form. The display screen shall scroll to reveal additional events.

D. Graphic Display:
   1. UV fade-resistant inks with unlimited color selection.
   2. Heavy-duty aluminum anodized frame.
   3. Security mounting hardware.
   4. Polycarbonate clear protective window.
   5. Approximately 24" x 18".

PART 1 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Perform work in accordance with the requirements of NFPA 70, NFPA 72 and NECA 1-2006, Standard of Good Workmanship in Electrical Contracting.

B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.

C. In the event that limited energy cable installation is allowed, all cable runs shall be run at right angles to building walls, supported from structure at intervals not exceeding 3 feet and where installed in environmental air plenums, be rated for such use and tied/supported by components listed for environmental air plenums installation.

D. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

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

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Provide primary power for each panel from normal/ emergency panels as indicated on the Electrical Power Plans. Power shall be 120 VAC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices.

3.3 BOXES, ENCLOSURES AND WIRING DEVICES

A. Boxes shall be installed plumb and firmly in position.

B. Extension rings with blank covers shall be installed on junction boxes where required.

C. Junction boxes served by concealed conduit shall be flush mounted.

D. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

E. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.

3.4 CONDUCTORS

A. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.

B. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.

C. Wiring for strobe and audible circuits shall be a minimum 14 AWG, signal line circuits minimum 18 AWG twisted.

D. All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer recommendations.

E. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

F. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

G. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

3.5 DEVICES

A. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.

B. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

C. All devices and appliances shall be mounted to or in an approved electrical box.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

C. A consistent color code for fire alarm system conductors throughout the installation.

3.7 EXTRA MATERIALS

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

3.8 ADDITIONAL COMPONENTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide labor and materials to provide (10) additional Ionization Area Smoke Detectors and 250 linear feet of fire alarm circuitry (in addition to those shown on plans). Install at locations as directed by Engineer.
   2. Provide labor and materials to provide (10) additional Duct Smoke Detectors, 250 linear feet of fire alarm circuitry, and RTS (and control circuitry) in addition to those shown on plans. Install at locations as directed by Engineer.
   3. Provide labor and materials to provide (10) additional Rate of Rise Temperature Heat Detectors and 250 linear feet of fire alarm circuitry (in addition to those shown on plans). Install at locations as directed by Engineer.
   4. Provide labor and materials to provide (10) additional Fixed Temperature Heat Detectors and 250 linear feet of fire alarm circuitry (in addition to those shown on plans). Install at locations as directed by Engineer.

3.9 FIELD QUALITY CONTROL

A. 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. Testing General:
   1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.

2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
4. Test reports shall be delivered to the acceptance inspector as completed.
5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
   a. Ladders and scaffolds as required to access all installed equipment.
   b. Multi-meter for reading voltage, current and resistance.
   c. Two way radios, and flashlights.
   d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
   e. Decibel meter.
   f. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

3.10 ACCEPTANCE TESTING

A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

B. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.

C. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.

D. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.

E. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

F. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 14 calendar days prior to the test date. A final acceptance test will not be scheduled until megger test results, the loop resistance test results, and the submittals required in Part 1 are provided to the owner. Test the system in accordance with the procedures outlined in NFPA 72.
   1. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
   2. Test each initiating and indicating device and circuit for proper operation and response. Disconnect the confirmation feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
   3. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.
   4. Visually inspect all wiring.

5. Verify that all software control and data files have been entered or programmed into the FACP.
6. Verify that Shop Drawings reflecting as-built conditions are accurate.
7. Measure the current in circuits to assure that there is the calculated spare capacity for the circuits.
8. Measure voltage readings for circuits to assure that voltage drop is not excessive.
9. Measure the voltage drop at the most remote appliance on each notification appliance circuit.

G. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      a. Open, shorted and grounded signal line circuits.
      b. Open, shorted and grounded notification, releasing circuits.
      c. Primary power or battery disconnected.
   2. System notification appliances shall be demonstrated as follows:
      a. All alarm notification appliances actuate as programmed
      b. Audibility and visibility at required levels.
   3. System indications shall be demonstrated as follows:
      a. Correct message display for each alarm input at the control display.
      b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.
      c. Correct history logging for all system activity.
   4. System off-site reporting functions shall be demonstrated as follows:
      a. Correct zone transmitted for each alarm input
      b. Trouble signals received for disconnect
   5. Secondary power capabilities shall be demonstrated as follows:
      a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
      b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
      c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

3.11 DOCUMENTATION

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
   1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM with copies of the record drawings in DXF format for use in a CAD drafting program.
   2. System operation, installation and maintenance manuals.
   3. System matrix showing interaction of all input signals with output commands.
   4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
   5. System program showing system functions, controls and labeling of equipment and devices.

3.12 PROTECTION

A. Remove and replace devices and panel components that are wet, moisture damaged, or mold damaged.

3.13 DEMONSTRATION

A. Instructor: Include in the project the services of an instructor, who shall have received specific training from the manufacturer for the training of other persons regarding the inspection, testing and maintenance of the system provided. The instructor shall train the employees designated by the owner, in the care, adjustment, maintenance, and operation of the fire alarm system. Provide sign-in sheet listing Owner's staff present at each training session.

B. Training sessions shall cover all aspects of system performance, including system architecture, signaling line circuit configurations, sensor and other initiating device types, locations, and addresses, fire alarm control panel function key operation, and other functions as designated by the owner.

C. Required Instruction Time: Provide 16 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the owner. The instruction may be divided into two or more periods at the discretion of the owner. One training session shall be videotaped by the contractor. Videotapes shall be delivered to the owner.

D. Provide a typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory and trouble. The instructions shall be approved by the owner.

E. Comprehensive system troubleshooting training shall be provided for a single individual designated by the owner. This session shall be separate and distinct from the above described sessions.

F. All training sessions shall be conducted following final system certification and acceptance. Three additional training sessions shall be provided for all security personnel on all shifts six months after final system certification.

G. All training sessions shall be conducted by an authorized fire alarm system distributor representative, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided.

3.14 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
   1. Be prepared to conduct any of the required tests.
   2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
   3. Have authorized technical representative of control unit manufacturer present during demonstration.
   4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
   5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
   1. Specified diagnostic period without malfunction has been completed.
   2. Approved operating and maintenance data has been delivered.
   3. Spare parts, extra materials, and tools have been delivered.
   4. All aspects of operation have been demonstrated to Owner.

5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
6. Occupancy permit has been granted.
7. Specified pre-closeout instruction is complete.

D. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.15 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventative maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventative maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

END OF SECTION

SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Subsoil materials.

B. Topsoil materials.

1.2 RELATED REQUIREMENTS:

A. Section 31 05 16 - Aggregates for Earthwork.

B. Section 31 22 00 - Grading.

C. Section 31 23 16 - Excavation.

D. Section 31 23 16.13 - Trenching.

E. Section 31 23 23 - Fill.

F. Section 32 92 19 - Seeding.

1.3 REFERENCE STANDARDS

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

C. ASTM D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).

D. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.4 SUBMITTALS

A. Section 01 30 00 - Administrative Requirements: Submittal Procedures

B. Materials Source: Submit name of imported materials source.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from a single source throughout the Work.

B. Perform Work in accordance with New York State DOT standards.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Excavated and re-used material or imported select borrow.

B. Graded.

C. Free of lumps larger than 3 inch, rocks larger than 2 inch, and debris.

D. Conforming to ASTM D 2487.

2.2 TOPSOIL MATERIALS

A. On-site Topsoil:
   1. Excavated and re-used material.
   2. Graded.
   3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.
      a. Screening: Single screened.
   4. Conforming to ASTM D 2487.

B. Imported Topsoil
   1. Imported borrow.
   2. Friable loam.
   3. Reasonably free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.
      a. Screening: Double screened.
   4. Acidity range (pH) of 5.5 to 7.5
   5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.
   6. Conforming to ASTM D 2487.
   7. Limit decaying matter to 5 percent of total content by volume.
   8. Imported soil shall be tested by a preapproved testing agency with a minimum of five years experience testing soils in the State of New York. Report/results shall be provided to engineer on soils ability to support proper grass growth before imported soil is brought onto the jobsite. Report/results shall contain testing agency's suggestions on fertilizers and any necessary additives in order for soil to provide a continual healthy growing environment for grass or other intended plants.
   9. Imported soils shall only be supplied to job from pre-approved borrow pits that have provided testing results to engineer. No topsoil shall be brought onto site without approval of engineer.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and analysis of soil material.

B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D 698, ASTM D 1557, and AASHTO T 180.

C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D 698, ASTM D 1557, and AASHTO T 180.

D. When tests indicate materials do not meet specified requirements, change material and retest.

E. Furnish materials of each type from the same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate subsoil from areas designated.

B. Stockpile excavated material meeting requirements for subsoil materials.

C. Remove excess excavated materials, and subsoil not intended for reuse from site.

D. Remove excavated materials not meeting requirements for subsoil and topsoil materials from site.

3.2 STOCKPILING

A. Stockpile materials on site as designated by Architect.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Stockpile topsoil 12 feet high maximum.

E. Prevent intermixing of soil types or contamination.

F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

G. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16

AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coarse aggregate materials.

B. Fine aggregate materials.

C. Blended aggregate materials.

1.2 RELATED SECTIONS:

A. Section 31 05 13 - Soils for Earthwork.

B. Section 31 23 16 - Excavation.

C. Section 31 23 16.13 - Trenching.

D. Section 31 23 23 - Fill.

1.3 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54kg (10 lb) Rammer and a 457 mm (18 in) Drop.

B. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).

D. ASTM D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3).

E. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

F. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

A. Section 01 30 00 - Administrative Requirements: Submittal Procedures.

B. Materials Source: Submit name of imported materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from a single source throughout the Work.

B. Perform Work in accordance with NYS DOT standards.

PART 2 PRODUCTS

2.1 COURSE AGGREGATE MATERIALS

A. CRUSHED STONE: Crushed stone shall be a mixture of 50% No. 1 & 2 crushed stone meeting all requirements in Section 703-02 of the NYSDOT Standard Specification or conform to AASHTO No. 57 coarse stone aggregate meeting all requirements in Section 703.3 of NYS DOT Form 408 Specifications.

B. GRANULAR FILL: Granular fill shall meet all requirements specified for Type 4 Subbase in Section 304-2.02 of the NYSDOT Standard Specification or No. 2RC aggregate in Section 703.3 of NYS DOT Form 408 Specification.

C. GRAVEL (STRUCTURAL) FILL: Gravel fill shall meet all requirements for Type 3 Subbase in Section 304-2.02 of the NYSDOT Standard Specification or Item 2A in Section 703.3 of NYS DOT Form 408 Specification.

2.2 FINE AGGREGATE MATERIALS

A. CUSHION SAND: Cushion sand shall consist of clean, hard, durable, uncoated particles, free from lumps of clay and all deleterious substances. It shall meet the following gradation requirements and shall be approved by the Engineer before use.

Sieve Size	Percent Passing by Weight
1/4 inch	100
No. 50	0-35
No. 100	0-10

B. PEA STONE: Stone meeting all requirements in Section 605-2.02 of the NYSDOT Standard Specification; free of shale, clay, friable material and debris. Pea stone shall consist of clean, durable rock of uniform quality.

Sieve Size	Percent Passing by Weight
1 inch	100
1/2 inch	30-100
1/4 inch	0-30
No. 10	0-10
No. 20	0-5

2.3 BLENDED AGGREGATE MATERIAL

A. CRUSHER RUN :Crusher run shall meet all requirements for Type 2 subbase in Section 304-2.02 of the NYSDOT Standard Specification or crushed No. 2A coarse aggregate in Section 703.3 of NYS DOT Form 408 Specification.

B. SELECT NATIVE FILL: General: On-site material shall be considered select fill if it is free from organic materials and debris, meets the following gradation and soundness requirements, and is approved by the Architect.

Sieve Size	Percent Passing by Weight
4 inch	100
No. 40	0-70
No. 200	0-15

Soundness: Less than 30 percent magnesium sulfate soundness loss.

C. UNCLASSIFIED FILL On-site material used as unclassified fill shall be free of stones larger than 8 inches in the largest dimension, shall be free of organic materials and debris, and shall be approved by the Architect.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and inspection services.

B. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D 698, ASTM D 1557, ASTM D 4318, ASTM C 136, and AASHTO T 180.

C. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698, ASTM D 1557, ASTM D 4318, ASTM C 136, and AASHTO T 180.

D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate aggregate materials from on-site locations as indicated on drawings or designated by Architect as specified in Section 31 23 16 - Excavation.

B. Stockpile excavated material meeting requirements for coarse aggregate and fine aggregate materials.

C. Remove excess excavated, coarse aggregate, and fine aggregate materials not intended for reuse from site.

D. Remove excavated materials not meeting requirements for coarse aggregate and fine aggregate materials from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations indicated or designated by Architect.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 23 16

EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for footings, slabs-on-grade, paving and site structures.

B. Trenching for utilities outside the building to utility main connections.

C. Temporary excavation support and protection systems.

1.02 RELATED REQUIREMENTS

A. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of benchmarks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring. General requirements for dewatering of excavations and water control.

B. Section 02 41 16 – Structure Demolition

C. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

D. Section 31 23 23 - Fill: Fill materials, backfilling, and compacting.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards current edition.

1.04 SUBMITTALS

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

B. Project Record Documents: Record drawings at project closeout according to 01 70 00 - Execution and Closeout Requirements. Show locations of installed support materials left in place, including referenced locations and depths, on drawings.

C. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bedding and Fill to Correct Over-Excavation:
1. See Section 31 23 23 for bedding and corrective fill materials at general excavations.
2. See Section 31 23 16.13 for bedding and corrective fill materials at utility trenches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey benchmark and intended elevations for the work are as indicated.

B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.

1. Resurvey benchmarks during installation of excavation support and protection systems and notify Owner if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Architect. If the proposed excavation extends more than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

3.02 PREPARATION

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

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Call Local Utility Line Information service (Pennsylvania One Call) at 1-800-242-1776not less than three working days before performing Work.

D. Request underground utilities to be located and marked within surrounding construction areas.

E. Notify utility company to remove and relocate utilities.

F. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving and curbs from excavating equipment and vehicular traffic.

G. Protect plants, lawns, rock outcroppings and other features to remain.

H. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
   1. Excavations in stable rock or in less than 5 feet (1.5 m) in depth in ground judged as having no cave-in potential do not require excavation support and protection systems.
   2. Depending upon excavation depth, time that excavation is open, soil classification, configuration and slope of excavation sidewalls, design and provide an excavation support and protection system that meets the requirements of 29 CFR 1926, Subpart P:
      a. Sloping and benching systems.
      b. Support systems, shield systems, and other protective systems.

B. Leave excavation support and protection systems, used as formwork or within 10 feet (3.03 m) of existing foundations, permanently in place, unless otherwise noted.
   1. Cut off top 4 feet (1.22 m) below grade, abandon remainder.

C. Excavation support and protection systems not required to remain in place may be removed subject to approval of Owner or Owner's Representative.
   1. Remove temporary shoring and bracing in a manner to avoid harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities and utilities.

3.04 EXCAVATING

A. Excavate to accommodate new structures and construction operations.
   1. Excavate to the specified elevations.
   2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
   3. Cut utility trenches wide enough to allow inspection of installed utilities.
   4. See Section 31 23 16.26 for required excavation clearances for pipes in utility trenches.

5. Hand trim excavations. Remove loose matter.

B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.05 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or regraded, marked areas, entire site, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material 36 mil Hypalon material and cover over with same material, until disposal.

D. Do not remove topsoil from site.

3.06 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or regraded. marked areas. entire site.

B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.

C. When excavating through roots, perform Work by hand and cut roots with sharp axe.

D. Remove excess subsoil not intended for reuse, from site.

E. Benching Slopes: Horizontally bench existing slopes greater than 1: 4 to key placed fill material to slope to provide firm bearing.

F. Stability: Replace damaged or displaced subsoil as specified for fill.

3.07 SUBGRADE PREPARATION

A. See Section 31 23 23 for subgrade preparation at general excavations.

B. See Section 31 23 16.13 for subgrade preparation at utility trenches.

3.08 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.

B. Install underground warning tape at buried utilities.

C. See Section 31 23 23 for fill, backfill, and compaction requirements at general excavations.

D. See Section 31 23 16.13 for fill, backfill, and compaction requirements at utility trenches.

3.09 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.

3.10 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces by Architect before placement of foundations.

3.11 CLEANING

A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 312200.

B. Remove excavated material that is unsuitable for re-use from site.

C. Remove excess excavated material from site.

3.12 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

E. Keep excavations free of standing water and completely free of water during concrete placement.

F. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 16.13
TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation trenches for utilities outside the buildings to utility main connections.

B. Compacted fill from top of utility bedding to subgrade elevations.

C. Backfilling and compaction.

1.2 RELATED REQUIREMENTS

A. Section 31 23 16 - Excavation: Building and foundation excavating.

B. Section 31 23 23 - Fill: Backfilling at building and foundations.

1.3 DEFINITIONS

A. Finish Grade Elevations: Indicated on site drawings.

B. Subgrade Elevations: Indicated on site drawings.

C. Utility: Any buried pipe, duct, conduit, or cable.

1.4 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

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

E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

F. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.5 SUBMITTALS

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

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

D. Compaction Density Test Reports.

E. Excavation Protection Plan: Describing sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

F. Product Data: Submit data for geo-textile fabric indicating fabric and construction.

G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where designated.
1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
2. Prevent contamination.
3. Protect stockpiles from erosion and deterioration of materials.

1.7 QUALITY ASSURANCE

A. Perform work in accordance with PENNDOT standards.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. See Section 31 23 23 - Fill.

B. See Section 31 05 13 - Soils for Earthwork.

C. See Section 31 05 16 - Aggregates for Earthwork.

2.2 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, woven.

2.3 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

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

3.3 TRENCHING

A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

G. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume.

H. Remove excavated material that is unsuitable for re-use from site.

I. Stockpile excavated material to be re-used in area designated.

J. Remove excess excavated material from site.

K. Do not advance open trench more than 100 feet ahead of installed pipe.

L. Excavate bottom of trenches maximum of 2 feet wider than outside diameter of pipe or as indicated on plans.

M. Excavate trenches to depth indicated on drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

N. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section or as required by OSHA.

O. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Architect/Engineer until suitable material is encountered. Notify Architect/Engineer, and request instructions prior to excavation.

P. Cut out soft areas of sub-grade not capable of compaction in place. Backfill with approved fill material and compact to density equal to or greater than requirements for subsequent backfill material.

Q. Correct over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Architect/Engineer.

3.4 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.5 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

G. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

H. Correct areas that are over-excavated.
   1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

I. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
   2. At other locations: 95 percent of maximum dry density.

J. Reshape and re-compact fills subjected to vehicular traffic.

K. Place geotextile fabric over bedding fill prior to placing subsequent fill materials.

L. Place fill material in continuous layers and compact in accordance with schedule at end of this section.

M. Employ placement method that does not disturb or damage foundation perimeter drainage, utilities in trench, and other below grade improvements.

N. Do not leave open trenching at end of working day.

O. Protect open trenches at all times during installation of trenching.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

3.7 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

C. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.8 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938.

C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.

D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Tests: 1 for every 50 feet of trench.

3.9 CLEANING

A. Leave unused materials in a neat, compact stockpile.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 31 23 23

FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, and site structures.

B. Proof Rolling.

C. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 31 05 13 - Soils for Earthwork: Soils for fill

C. Section 31 05 16 - Aggregates for Earthwork: Aggregate for fill

D. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.

E. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.3 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: Indicated on drawings.

1.4 REFERENCE STANDARDS

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

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

E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

G. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.5 SUBMITTALS

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

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

D. Compaction Density Test Reports.

E. Product Data: Submit data for geotextile fabric indicating fabric and construction.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations or where native materials are not suitable for use.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Satisfactory soil materials.

E. Base: NYSDOT type 2 crushed ledge rock.

F. Bedding Stone: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

G. Drainage Stone: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

H. Structural Fill: Well-graded sand and gravel or crushed rock product which is capable of being compacted to required density at the proper moisture content and which is free of deleterious materials, trash, roots, debris, frozen material and organic or other foreign matter. Fill material shall be accepted on the basis of gradation, soundness, plasticity index, and a well defined moisture-Density Relationship Test (ASTM 1557, Modified Proctor). Soundness shall be less than 30% loss based on a four-cycle magnesium sulfate soundness test. Plasticity Index of that portion of fill material passing the No. 40 mesh sieve shall not exceed 5.0. Gradation of the materials shall be within the following limits:

PERCENT PASSING BY WEIGHT	SIEVE SIZE
100	4 inch
90-100	2 inch
30-65	1/4 inch
5-40	No. 40
0-10	No. 200

I. Cushion Sand: Clean, hard, durable, uncoated particles, free from lumps of clay and all deleterious substances conforming to the following limits of gradation when dry:

PERCENT PASSING BY WEIGHT	SIEVE SIZE
100	1/4 INCH
0-35	No. 50
0-10	No. 100

J. IMPORTED TOPSOIL FOR PLANTING BEDS AND LAWN ESTABLISHMENT

1. Imported topsoil: ASTM D 5268, pH range of 5.5 to 7, 4 percent organic material minimum, free of sub-soil, earth clods, sticks, stumps, clay lumps, roots and stones 1 inch (25 mm) or larger in any dimension, and other extraneous materials harmful to plant growth. Topsoil shall also be free of Quack-grass rhizomes, Argrpyron reptans, and the nut-like tubers of Nutgrass, Cyperus esculentus and all other primary noxious weeds. Imported topsoil shall be screened and shall conform to the following gradations.

	Approximate Particle Distribution	Size
Gravel	Less than 10%	+2mm
Coarse to medium sand	60-75%	0.25-2mm
Fine sand	5-10%	0.1-0.25mm
Very fine sand	0-5	0.05-0.1mm
Silt	10-30%	0.002-0.05mm
Clay	15-20%	minus 0.002mm

2. Imported topsoil Source: Import topsoil from off-site sources. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from bogs or marshes. If topsoil cannot be found locally that complies with the specifications, the contractor should be prepared to create a manufactured soil product using the available topsoil as a base and amending as directed by the Architect, at no additional expense to the owner.

2.2 ACCESSORIES

A. Filter Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
   1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
   2. Tear Strength: 40 lbf (178 N); ASTM D 4533.
   3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
   4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
   5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.

B. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
   1. Grab Tensile Strength: 200 lbf (890 N); ASTM D 4632.
   2. Tear Strength: 75 lbf (333 N); ASTM D 4533.
   3. Puncture Resistance: 90 lbf (400 N); ASTM D 4833.
   4. Water Flow Rate: 4 gpm per sq. ft. (2.7 L/s per sq. m); ASTM D 4491.
   5. Apparent Opening Size: No. 30 (0.6 mm); ASTM D 4751.

C. Warning Tape: Acid and alkali resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6-inches wide and 4-mils thick, continuously inscribed with a description of the utility. Provide tape colors to utilities as follows:
   1. Red: Electric
   2. Yellow: Gas, oil, steam
   3. Orange: Telephone and other Communications
   4. Blue: Water
   5. Green: Sewer systems.

2.3 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. Verify subdrainage, or waterproofing installation has been inspected.

D. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.2 PREPARATION

A. Scarify subgrade surface to a depth of 8 inches.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Compact subgrade to density requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

E. The subgrade and subbase shall be thoroughly proof rolled. Contact engineer or owner's representative 24 hours before testing. If subgrade stabilization or undercutting is designed for the project, then proof rolling shall be used to verify the undercut replacement material stability.

F. Proof rolling deflections and soil conditions that are observed during construction determine if the plan subgrade treatment must be adjusted. Adjustment of subgrade treatment to fit field conditions is essential and is the responsibility of the contractor and Construction Manager on site.

G. Provide subgrade corrections prior to proof rolling

H. When rutting and deflection occur under wheels of 10-wheel dump truck engineer or representative will require corrective action

I. Improve subbase or subgrade by undercutting wet material, aeration of wet soil or use of additional subbase material. Compact material and proof roll again.

J. If needed, make the correction by excavating and disposing of soft grade, and replacing it with NYSDOT type 4 subbase material.

K. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

L. The proof rolling should be done immediately after the subgrade compaction operation, when the moisture content of the subgrade soil is near optimum or at the moisture content that achieved compaction. This minimizes the chances of the subgrade becoming too wet or too dry for an effective proof rolling evaluation. If the subgrade is too wet, the material will displace and rut. If the subgrade is too dry, a dry hard surface crust may carry the proof roller over an undesirable soft wet underlying material without rutting or deflection, and the soft subgrade may not be detected.

M. Proof rolling may be done either before or after pipe underdrains are installed. If done after underdrains are installed, rolling should not be done directly over the underdrains. Proof rolling must be performed at least 1-½ feet (0.5 meters) away from the underdrains because of the potential damage to the underdrains.

N. Any unsuitable materials that may be found should be separated and wasted or reused in landscaped areas only.

3.3 FILLING

A. Foundation backfill shall consist of structural fill or suitable granular fill. Excavated on site soils (sand and gravel) may be considered as foundation backfill provided the material is reasonably uniform in composition and adequate compaction can be achieved at the time of placement.

B. All existing fill materials are to be removed from beneath proposed building floor slabs.

C. Fill to contours and elevations indicated using unfrozen materials.

D. Fill up to subgrade elevations unless otherwise indicated.

E. Employ a placement method that does not disturb or damage other work.

F. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

G. Maintain optimum moisture content of fill materials to attain required compaction density.

H. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

I. Subsoil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

J. Structural Fill: Place and compact material in equal continuous layers not exceeding 6 inches compacted depth.

K. Slope grade away from building minimum 2 percent slope for minimum distance of 5 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

L. Place geo-textile fabric over approved fill prior to placing next lift of fill.

M. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.

N. Backfill simultaneously on each side of unsupported foundation walls until supports are in place

O. Correct areas that are over-excavated.
   1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 100 percent of maximum dry density.
   2. Other areas: Use structural fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.

P. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density.

Q. Reshape and re-compact fills subject to vehicular traffic.

R. Remove surplus backfill materials from site.

S. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

B. Top Surface of Filling Within Building Areas: Plus or minus 1/2 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938. Contractor shall be responsible for providing compaction testing as part of their base bid contract. Slab testing shall be every 100 square feet of area or every 50-ft of trench excavation.

C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.

D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Tests: 1 test for every truck load of material delivered.

F. Proof roll compacted fill at surfaces that will be under slabs-on-grade., pavers, and paving.

3.6 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

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