sfL+a
ARCHITECTS
Capital Bank Plaza
333 Fayetteville Street, Suite 225
Raleigh NC 27601

PROJECT MANUAL

VOLUME 2 (of 2)

Divisions 20 thru 39

Moore County Schools
5277 Hwy. 15-501 South
Carthage, NC 28327

Gym Modernizations/Renovations Phase 2

Architect's Project Number: 02206.100

Job Site Locations:

Sandhills Farm Life Elementary School
2201 Farm Life School Road
Carthage, NC 28327

Vass-Lakeview Elementary School
141 James Street
Vass, NC 28394

November 22, 2023
Bid Set

Set Number: _____

SECTION 00 01 01

PROJECT TITLE PAGE

Date

November 22, 2023
Bid Set

Project Identification

Gym Modernizations/Renovations - Phase 2
Architect Project No.: 02206.100

Job Site Locations:

Sandhills Farm Life Elementary School
2201 Farm Life School Road
Carthage, NC 28327

Vass-Lakeview Elementary School
141 James Street
Vass, NC 28394

Owner

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Telephone: 910-947-2976

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SfL+a Architects
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Plumbing Engineer
Mechanical Engineer
Electrical Engineer

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2638 Willard Dairy Road, Suite 100
High Point, NC 27265
Telephone: 336-454-0225

Roofing Engineer

Terracon Consultants, Inc.
2401 Brentwood Road, Suite 107
Raleigh, NC 27604
Telephone: 919-873-2211

END OF SECTION

SECTION 00 01 07

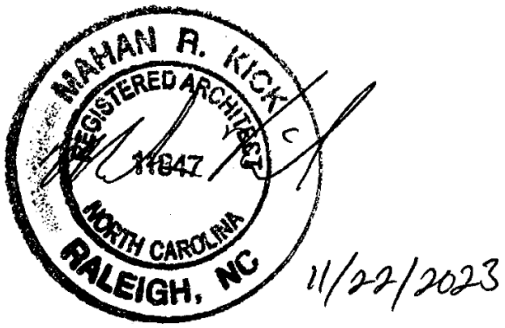
SEALS PAGE

Architectural

SfL+a Architects, PA
NC Corporate Registration
NC Registration Number 50676

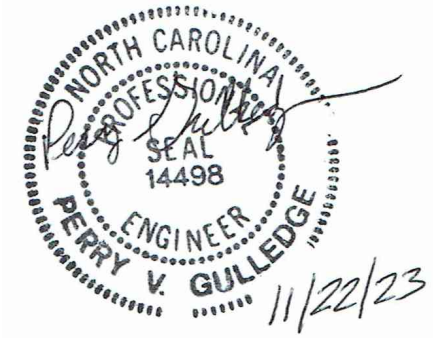
Architectural

SfL+a Architects, PA
Mahan Raspa Kick
NC Registration Number 11847



Plumbing Engineering
Mechanical Engineering
Electrical Engineering

Triad Engineering Consultants, Inc.
Perry V. Gulledge
NC Registration Number 14498



Roofing Engineering

Terracon Consultants, Inc.
Jeffery H. Poe, Jr.
NC Registration Number 045268

END OF SECTION

SECTION 00 01 10

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SECTION 22 05 05

COMMON PLUMBING REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General project related items that apply to all Division 22 sections. The provisions included in this section are complementary to and amendatory of the Division 1 sections of these project specifications - they do not replace them.

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to this section. Where conflicts may exist between Division 1 Specifications Sections and Division 22 Specification Sections, the Division 1 provisions shall take precedence except for when the Division 22 provisions expand, enhance, or extend the project, material or equipment requirements.

1.03 REFERENCES

A. FM P7825 - Approval Guide; Factory Mutual.

B. NEMA MG 1 - Motors and Generators.

C. NFPA 70 - National Electrical Code.

D. SSPC-Paint 15 - Steel Joist Shop Paint; Steel Structures Painting Council.

E. North Carolina State Building Code (All Volumes)

1.04 DEFINITIONS

A. Building Code: Collectively, the current editions of all applicable codes whose requirements must be met in order for the Building Owner to be granted an Occupancy Permit by the authorities having jurisdiction over the building. These codes shall include but not be limited to the following specific volumes as well as any additional codes or standards referenced in these publications:

1. General Construction.
2. Administrative.
3. Accessibility.
4. Plumbing.
5. Mechanical.
6. Electrical.
7. Fire Prevention.
8. Fuel Gas.
9. Energy Conservation.

B. Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing work or offering to perform work. The term "Contractor" shall apply to such entity regardless of whether the entity is working as a Prime Contractor or as a Sub Contractor on the project.

1. Prime Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing or offering to perform work and who is awarded a contract with the Owner for work on this project.
2. Sub Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing or offering to perform work and who is working on the project under contract with a Prime Contractor.

C. Collectively, the current editions of all applicable laws whose requirements must be met in order for the Building Owner to provide access to the public and to occupy and conduct business lawfully including any additional laws, codes or standards referenced in these laws. These laws include but are not limited to the following:

1. Americans With Disabilities Act.

2. Energy Policy Act.

D. Provide: When used in these specifications or on the drawings, the term "provide" shall mean to furnish, install, and adjust as required for safe and efficient operation.

E. Supply: When used in these specifications or on the drawings, the term "supply" shall mean to furnish with all required appurtenances for a complete installation and advise the installing contractor on details relating to the installation as needed.

F. Applicable version of referenced standards: Wherever standards are referenced throughout these specifications and on the drawings, the version applicable will be the year that is referenced in the current version of the Building Codes. Where later versions have been published, but not officially adopted into the current Building Codes, the later versions do not apply to this project.

1.05 GENERAL PROJECT REQUIREMENTS

A. The plans and specifications for this project are prepared to represent the general project requirements and intent. They are diagrammatic in nature and are not intended to show each and every fitting, offset, or other modifications or minor devices that may be required in the field to provide a complete system that is safe, efficient and effective in operation. Minor components or modifications that are required to provide a safe, efficient and effective system shall be included in the bid price whether or not they are specifically called for on the plans or in these specifications. It is understood that the contractors bidding this project are required to be licensed in their respective trade and are therefore knowledgeable in the trade in which they are licensed.

B. The Contractor shall provide all contingencies and supply all tools, fixtures, transportation, etc as well as materials necessary for installation. In all its details, the work and materials shall be subject to the approval of the Architect or Engineer whose decision on all points of difference shall be final and binding on this Contractor.

C. The Contractor shall secure and pay for all necessary approvals, permits, inspections, certificates etc. required by state or local codes or statutes, rules, or regulations and pay all fees required unless specifically noted otherwise.

D. All work and materials are required to be in compliance with State and Local Codes. Any conflicts between the plans and State or Local Codes, Rules, Statutes, or Regulations shall be brought to the Architect's or Engineer's attention in writing immediately.

E. Plans are diagrammatic in nature and show the general design and arrangement of the systems. They are not intended to show each and every offset or fitting required for installation of work under this contract. This Contractor, as a licensed professional, is required to be proficient and knowledgeable in his trade and is required to include all such items and contingencies in his bid. The plans are not to be scaled for rough-in dimensions nor are they to be used for shop drawings.

1. Where dimensions are given on the plans, they must be verified with actual field measurements taken on the project site. This Contractor shall take such field measurements as required to coordinate the installation of his work or to prepare shop drawings.

2. Slight relocation of fixtures, equipment, devices and other items may be made by this Contractor as required to fit his work to casework, trim, brick coursing, etc as long as such relocation does not interfere with work of any other Contractor.

F. Cutting, patching and firestopping for all work under this contract will be the responsibility of the installing contractor. Holes shall be cut in walls, floors, ceilings, etc as required for installation of materials, access for installation of materials - or other reasons as may require cutting - by this contractor for all of his work. Patching holes and spaces around installed materials or equipment shall also be by this contractor.

1. All penetrations through walls, floors, ceilings, etc shall be sealed. Leave all patched surfaces in exposed locations ready for application of final finishes. Leave patched surfaces in concealed locations neat in appearance and continuous around all sides of the penetration.

2. For non rated partitions, seal with caulk, grout or other approved material that is appropriate for the substrate that the patch is matched to. For 1 hour rated partitions, seal with approved non combustible materials as listed in the State Building Code. For penetrations in partitions with fire resistance ratings in excess of 1 hour, firestop penetrations with UL listed firestopping assemblies approved for the penetrating materials as well as the partition type and materials.

1.06 COORDINATION OTHER DIVISIONS

A. Requirements noted in this division are intended to be supplementary to Division 1 requirements. Where Division 1 requirements exceed the requirements in this section, the Division 1 requirements shall govern. Where requirements in this section exceed Division 1 requirements, the requirements in this division shall govern. This Contractor is required to review the Division 1 requirements as well as other Divisions to allow coordination of his work with other trades.

1.07 PERFORMANCE REQUIREMENTS

A. All equipment installed in fire rated walls, ceilings, or other partitions shall be listed to maintain the fire rating and shall be installed to maintain the rating.

B. Materials (such as conduit, pipes, ducts, etc.) passing through fire rated walls, ceilings or other partitions shall be suitably firestopped using only approved materials and methods to maintain the fire rating of the assembly.

C. Schedule all required inspections by State and Local Authorities, and make all corrections as required by such inspections.

1.08 SUBMITTALS

A. Shop Drawings: Submit shop drawings as specified in the respective specification section. When equipment, materials or systems other than the one specified are submitted, this Contractor shall be required to clearly mark differences between the items submitted and the items specified. This Contractor shall be responsible for all changes required (including but not limited to piping, wiring, mounting, clearances, etc) under this and other divisions due to the use of items other than those specified.

1. Submit shop drawings in one complete package and not at intervals.
2. The Contractor shall check each submittal for accuracy and completeness prior to submitting the shop drawings to the Engineer. The Contractor shall stamp and sign the documents accordingly
3. Each item being submitted for review shall be clearly identified in the submittal. In the event that multiple items are cataloged in a section and a single item is not clearly identified as the one that is being submitted, the Engineer may at his discretion select any suitable item from the page that meets or exceeds the requirements for the project.

1.09 QUALITY ASSURANCE

A. Perform in accordance with state and local building codes, laws and ordinances.

B. Obtain and pay for all inspections, permits, and fees required for work under this contract.

C. Substitutions: Substitutions shall be made in accordance with the procedures given in the applicable Division 1 sections. The following procedures shall supplement the procedures given in Division 1. In the event that there are not substitution procedures given in Division 1, these procedures shall be used for all Division 22 and Division 16 items.

1. When equipment, materials or systems other than the one specified are submitted, this Contractor shall be required to clearly mark differences between the items submitted and the items specified. This Contractor shall be responsible for all changes required (including but not limited to piping, wiring, mounting, clearances, etc) under this and other divisions due to the use of items other than those specified. The costs for these required changes shall be borne by the Contractor making the substitution at no additional costs to the Owner. The Engineer's decision on the acceptability of substitute equipment shall be final and binding under this contract. The acceptance of substitute items shall in no way relieve the Contractor from meeting any of the project requirements.
2. Items that are to be substituted for a specified item shall be equal in quality, performance, capacity, size, construction, utility requirements, appearance, etc to the item specified.
3. Substitutions may be made for all items specified using the term "or equal". Where an item is specified without the use of the term "or equal" that item must be used for the project bid. No substitutions may be made for items that are specified without the "or equal" term.
4. Items exceeding the performance, efficiency, quality, etc may be used when approved by the Engineer, but no additional money will be paid under the contract for such features.
5. The Engineer may consider qualities and characteristics of the specified item which may or may not have been specifically called out in the schedules or specifications when evaluating

the suitability of a substitute item. The Engineer's decision regarding the acceptability of substitute items shall be final and binding under this contract.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience and properly licensed to perform the work.

E. Install equipment to comply with the Americans With Disabilities Act requirements.

1.10 DELIVERY, STORAGE, AND PROTECTION

A. Store materials and equipment under cover and elevated above grade until ready for installation.

B. Deliver materials and products to project site in their original shipping containers.

1.11 PROJECT CONDITIONS

A. Coordinate new work installation with size, location and installation of any existing service utilities. Field verify all locations of utilities prior to beginning work and as necessary during project progress.

B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.12 WARRANTY

A. All labor, materials, and products supplied on this project shall have a minimum of 1 year parts and labor replacement warranty.

B. Consult individual specification sections for additional warranty requirements. Warranty requirements stated in the subsequent specifications sections are supplemental to requirements in this warranty section.

C. Correct defective Work within a one year period after Date of Substantial Completion unless a different date is given in Division 1 specifications sections. Provide all materials, labor, supplies etc. as required to remove, disassemble, replace, reassemble, etc. the failed or otherwise defective parts that are covered under the warranty terms.

D. Provide five year manufacturer warranty for parts of all compressors.

1.13 MAINTENANCE SERVICE

A. Provide service and maintenance of all equipment installed under this contract for 12 months from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials and equipment supplied on this project shall comply with the applicable standards for the material or equipment where such standard exists. All items shall be listed by Underwriters Laboratories or other approved third party listing agency where a listing is available.

B. All materials and equipment used on the project shall be new unless specifically specified otherwise in the Project Plans or Specifications.

C. All equipment used on the project shall be the latest current production model available at the time of bidding. No discontinued, superseded, suspended production models or otherwise obsolete equipment shall be used on this project. In the event that equipment is discontinued, superseded, or production is suspended on the models bid, current production models shall be substituted and so noted on the shop drawing submittals.

D. All materials and equipment shall be in accordance with the North Carolina State Building Code (all volumes), local codes and ordinances and shall be approved for the intended use on the project.

E. Materials and equipment of a similar type shall be supplied by the same manufacturer where possible. Do not provide similar products from two or more manufacturers unless a highly specialized item without equal has been specified. Do not provide similar products from two or more manufacturers if the items must fit together to provide their intended function.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are proper for the installation of material or equipment prior to installing such equipment. Correct (or have corrected) any unsatisfactory conditions prior to installing materials or equipment.

3.02 INSTALLATION

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations. Supply additional materials and labor as may be recommended by the manufacturer or where required for compliance with codes for the best installation of the materials or equipment whether such items are specifically called for otherwise in the project plans or specifications.

B. Unless specifically shown otherwise on the plans, install all piping, concealed from view of finished spaces.

C. Coordinate rough-in of plumbing fixtures, thermostats, etc with the requirements of the Americans With Disabilities Act requirements.

D. Install all equipment, materials, components, etc. in accordance with the applicable Building Code requirements and Building Related Laws. The project plans and specifications are prepared with the knowledge that bidders must be licensed contractors in their respective trade, and as such, are required to be knowledgeable of code and law requirements. All materials, components, accessories or other appurtenances required by code or law for a proper, safe, efficient, and legal installation shall be included in the project base bid price. Any and all work, materials, equipment, supplies or other items made necessary by code or law requirements shall be included in the project base bid price whether or not said items are specifically called for on the project plans or in the specifications. No additional charges shall be allowed to the contract for items that are legally required by such code or laws.

E. Provide all cutting and patching as required for installation of materials or equipment under this contract except where specifically noted otherwise on the plans.

F. Where applicable, provide all demolition, disassembly, removal, transportation, and legal disposal of existing items that are not being reused or salvaged.

G. Label all equipment and piping installed as well as all existing equipment and piping that remain on this project. Label equipment with engraved laminated phenolic plates secured to the exterior of the equipment. Label valves with brass valve tags and provide a Valve Tag Schedule. Label above ground pipes with the medium in the pipe and the flow direction.

H. Identify underground piping by installing a plastic tape with indicator wire approximately 6" above the pipe.

I. Provide all trenching and backfilling required for installation of work in this project. Backfill in 8" lifts and compact to 95% proctor unless a different compaction level is listed on the plan or in the earthwork sections of the specifications. Seed and straw disturbed grass areas. Patch disturbed paved areas equal to the adjacent paving. Provide new mulch for disturbed mulched areas.

3.03 INTERFACE WITH OTHER WORK

A. This Contractor shall coordinate his work with that of all other Contractors on the project and shall consult the drawings and specifications of the other trades to determine the nature and effect of work by others. This Contractor shall be responsible for all his work fitting in place with in an approved manner, and shall consult with others as required for drawings, dimensions, elevations, actual building measurements, etc. as necessary to ensure that his work does fit properly and does not conflict with other trades.

B. In the event that interferences develop, this Contractor shall cooperate with others to eliminate the interference. Should pipes, ductwork, equipment or other items have to be relocated, the Architect's or Engineer's decision will be the final authority as to which Contractor shall relocate his work.

C. Coordinate voltage and current characteristics of all equipment installed with other Contractors, Subcontractors or Owner on the project.

D. Coordinate the power connections for all equipment installed by this Contractor with other Contractors on the project.

E. Consult the kitchen equipment shop drawings to determine exact rough-in and connection locations for kitchen equipment.

F. Do not route pipes over electrical panelboards

G. Do not route pipes through ductwork.

3.04 FIELD QUALITY CONTROL

A. Thoroughly inspect equipment installed on this project for proper installation prior to start-up of the equipment.

B. Adjust and test each piece of equipment to insure that all operating and safety controls are functioning safely, properly and efficiently. Replace any defective items that would prevent such operations.

3.05 STARTING EQUIPMENT AND SYSTEMS

A. Adjust for proper operation within manufacturer's published tolerances.

B. Demonstrate proper operation of systems to Owner's designated representative and instruct him in the proper maintenance procedures of each system.

3.06 ADJUSTING

A. Adjust equipment for smooth, quiet, safe and efficient operation.

3.07 CLEANING

A. Clean all equipment, piping, labels, mechanical rooms, attics etc prior to project closeout. All construction debris is to be removed and properly disposed of. Remove all stains and drips from the equipment and from the building.

B. Protect installed material and equipment from subsequent construction operations.

C. Do not permit traffic over unprotected floor surface.

END OF SECTION 22-05-05

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.02 REFERENCE STANDARDS

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

1.03 SUBMITTALS

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

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

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.

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

C. Chart: Typewritten letter size list in anodized aluminum frame.

2.03 STENCILS

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.
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.
7. Stencil Paint: Semi-gloss enamel, colors conforming to ASME A13.1.

2.04 PIPE MARKERS

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.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:

1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.
3. Plumbing Valves: Green.
4. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

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

B. Degrease and clean surfaces for stencil painting.

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

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify thermostats relating to terminal boxes, air handling units, or valves with nameplates.

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

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. 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.

M. Install ductwork with stencilled painting. 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.

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

END OF SECTION 22 05 53

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to this section. Where conflicts may exist between Division 1 Specifications Sections and Division 23 and 25 Specification Sections, the Division 1 provisions shall take precedence except for when the Division 23 and 25 provisions expand, enhance, or extend the project, material or equipment requirements.

1.03 REFERENCE STANDARDS

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

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

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

D. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

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

F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.

G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc..

1.04 SUBMITTALS

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

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

1.05 QUALITY ASSURANCE

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

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

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

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

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

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER

A. Insulation: ASTM C547 ; 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.

B. 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.
   1. White kraft paper with glass fiber yarn, bonded to aluminized film per ASTM C921.
   2. Moisture vapor transmission: ASTM E 96; 0.02 perm-inches.

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

D. Vapor Barrier Lap Adhesive:
   1. Compatible with insulation.

E. Insulating Cement/Mastic:
   1. ASTM C195; hydraulic setting on mineral wool.

F. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Weave: 5x5.

2.03 JACKETS

A. Canvas Jacket: UL listed.
   1. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   2. Lagging Adhesive:
      a. 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

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.
   1. Finish insulation systems that are exposed in Mechanical Rooms or other locations with canvas or fiberglass cloth covered with mastic to create a durable firm finish.
   2. Paint finish to Owner's color keyed identification system.

D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, 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 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. Finish with PVC fitting covers.

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

J. 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.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

L. 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.

M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.02 SCHEDULES

A. Plumbing Systems:
   1. Domestic Cold Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: 1/2"-1" inch.
            (a) Thickness: 1/2 inch.
         2) Pipe Size Range: 1-1/4" - 3" inch.
            (a) Thickness: 1 inch.
   2. Domestic Hot Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: 1/2"-1" inch.
            (a) Thickness: 1/2 inch.
         2) Pipe Size Range: 1-1/4" - 3" inch.
            (a) Thickness: 1 inch.
   3. Roof Drain Bodies:
      a. Glass Fiber Insulation: 1" wall thickness with all service jacket.
   4. Roof Drainage Above Grade:
      a. Glass Fiber Insulation: 1" wall thickness with all service jacket.

END OF SECTION 22-07-19

SECTION 22 10 05

PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.
   3. Storm water.

1.02 RELATED REQUIREMENTS

A. Section 22 07 19 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

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

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

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

D. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers.

E. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

G. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).

I. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

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

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

L. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

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

N. ASTM F 708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

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

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

Q. 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.

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

S. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.

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

U. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

V. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

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

X. MSS SP-67 - Butterfly Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

Y. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

Z. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

1.04 SUBMITTALS

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

B. Project Record Documents: Record actual locations of pipe and valves.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

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

C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

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

E. Conform to applicable water supplier's requirements for type and installation of backflow prevention devices.

1.06 DELIVERY, STORAGE, AND HANDLING

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

B. Provide temporary protective coating on cast iron and steel valves.

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

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.10 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joint Seals: ASTM C564 elastomer gaskets, or lead and oakum.

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

2.11 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

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

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

2.12 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.
1. Fittings: Cast iron.

2. Joint Seals: ASTM C564 elastomer gaskets, or lead and oakum.

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

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

2.13 WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B 32, alloy Sn95 Tin-Antimony solder. (For piping up to 1-1/4" nominal diameter.)
3. Joints: AWS A5.8, Silver alloy brazing filler BAg1. (For piping 1-1/2" nominal diameter and larger.)

2.14 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.

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

2.15 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joint Seals: ASTM C564 elastomer gaskets, or lead and oakum.

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

2.16 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
1. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.17 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. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
   a. Bases: High density polypropylene.
   b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
   d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.

e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

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. 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 Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded supports or 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 for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.

2.18 GLOBE VALVES

A. Up To and Including 3 Inches:
1. MSS SP-80, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder or threaded ends as appropriate for the application.

2.19 BALL VALVES

A. Manufacturers:
1. Conbraco Industries;: www.apollovalves.com.
2. Grinnell Mechanical Products, a Tyco International Company: www.grinnell.com.
3. Nibco, Inc: www.nibco.com.
4. Milwaukee Valve Company: www.milwaukeevalve.com.

B. Construction, 4 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 with balancing stops, solder ends with union.

2.20 PLUG VALVES

A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.21 BUTTERFLY VALVES

A. Manufacturers:
   1. Tyco Flow Control: www.tycoflowcontrol.com.
   2. Hammond Valve: www.hammondvalve.com.
   3. Crane Co.: www.cranevalve.com.

B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.22 SWING CHECK VALVES

A. Manufacturers:
   1. Hammond Valve: www.hammondvalve.com.
   2. Nibco, Inc: www.nibco.com.
   3. Milwaukee Valve Company: www.milwaukeevalve.com.

B. Up to 3 Inches:
   1. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.

2.23 SPRING LOADED CHECK VALVES

A. Manufacturers:
   1. Hammond Valve: www.hammondvalve.com.
   2. Crane Co.: www.cranevalve.com.
   3. Milwaukee Valve Company: www.milwaukeevalve.com.

B. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 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.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

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

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

E. Install piping to allow removal of equipment without requiring the removal of pipe sections.

F. Group piping whenever practical at common elevations.

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

H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.

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

J. Establish elevations of buried piping outside the building to ensure not less than one and one half ft of cover.

K. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; .
   1. Single-ply roofs: G.C. will supply and install flashing materials on vent piping.
   2. Built-up roofs: Install sheet lead slashing assemblies or other approved flashing materials.

3. Metal Roofs: G.C. to supply flashing assemblies. Install under this contract.
4. Shingled Roofs: Provide flashing assemblies.

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

M. Provide support for utility meters in accordance with requirements of utility companies.

N. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.

O. Excavate in accordance with Division I Sections for work of this Section.

P. Backfill in accordance with Division I Sections for work of this Section.

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

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

S. Install valves at no more than 45 degrees from the upright position.

T. Support cast iron drainage piping at every joint.

U. Install water piping to ASME B31.9.

V. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

W. Sleeve pipes passing through partitions, walls and floors. Seal airt and water tight between the sleeve and pipe with approved sealant material.

X. 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. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.
8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
9. Support cast iron drainage piping at every joint.
10. Paint gas piping that is exposed in the attic and in the building with two coats of oil based enamel paint. The color shall be safety yellow unless noted or directed otherwise by the Architect or Engineer.

3.04 APPLICATION

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

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install globe or ball valves for throttling, bypass, or manual flow control services.

E. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

F. Provide spring loaded check valves on discharge of water pumps.

G. Provide plug valves in gas systems for shut-off service.

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

3.05 TOLERANCES

A. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

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

B. 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).

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

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

E. Maintain disinfectant in system for 24 hours.

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

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

H. 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.

3.07 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. Plastic Piping:
      a. All Sizes:
         1) Maximum hanger spacing: 6 ft.
         2) Hanger rod diameter: 3/8 inch.

END OF SECTION 22 10 05

SECTION 22 10 06

PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof and floor drains.

B. Floor drains.

C. Cleanouts.

D. Hose bibbs.

E. Hydrants.

F. Backflow preventers.

G. Water hammer arrestors.

1.02 RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping.

B. Section 22 40 00 - Plumbing Fixtures.

C. Section 22 30 00 - Plumbing Equipment.

1.03 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers.

B. ASSE 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering (ANSI/ASSE 1011).

C. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering (ANSI/ASSE 1019).

D. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute.

1.04 SUBMITTALS

A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

C. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors, and valves.

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

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

1. Two loose keys for outside hose bibs.

PART 2 PRODUCTS

2.01 DRAINS

2.02 ROOF DRAINS:

A. Roof drains will be supplied and installed by the General Contractor. Connection to the drain with a flexible connector will be required under this section.

2.03 ROOF OVERFLOW DRAINS:

A. Overflow drains will be furnished and installed by the General Contractor. Connection to the drain with a flexible connector will be required under this section.

2.04 DOWNSPOUT NOZZLES:

A. Bronze round with offset bottom section.

B. Internal screen assembly for pipe sizes larger than 2"

2.05 FLOOR DRAINS:

A. Floor Drain for "finished" areas: Equal to Zurn ZN415 with square Nickalloy top.
   1. ASME A112.21.1M; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and square, adjustable nickel-bronze strainer.

2.06 FLOOR SINKS

A. Rectangular cast iron with acid resistant enamel interior coating, aluminum dome strainer and nickaloy top grate.

2.07 CLEANOUTS

A. Cleanouts at Interior Finished Floor Areas:
   1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and square gasketed depressed cover to accept floor finish in finished floor areas.

2.08 HOSE BIBBS

A. Interior Hose Bibbs:
   1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with lockshield and removable key, integral vacuum breaker in conformance with ASSE 1011.

2.09 HYDRANTS

A. Wall Hydrants:
   1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.

2.10 REFRIGERATOR VALVE AND RECESSED BOX

A. Description: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.11 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers:
   1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.12 WATER HAMMER ARRESTORS

A. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

2.13 MIXING VALVES

2.14 THERMOSTATIC MIXING VALVES:

A. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.

B. Accessories:
   1. Check valve on inlets.
   2. Volume control shut-off valve on outlet.
   3. Stem thermometer on outlet.
   4. Strainer stop checks on inlets.

C. Cabinet: 16 gage prime coated steel, for recessed mounting with keyed lock.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage

system.

C. Encase exterior cleanouts in a 12"x12"x6" minimum concrete pad flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to quick acting valves such as flush valves, solenoid actuated valves, etc.

END OF SECTION 22 10 06

SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water heaters.

B. Pumps.
   1. Circulators.

1.02 REFERENCE STANDARDS

A. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Underwriters Laboratories Inc..

B. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Underwriters Laboratories Inc..

1.03 SUBMITTALS

A. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide electrical characteristics and connection requirements.

B. Shop Drawings:
   1. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

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

1.04 QUALITY ASSURANCE

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

1.05 CERTIFICATIONS

A. Electric Water Heaters: UL listed and labeled to UL 174 or UL 1453.

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.07 WARRANTY

A. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATER MANUFACTURERS

A. A.O. Smith Water Products Co: www.hotwater.com.

B. Bock Water Heaters, Inc: www.bockwaterheaters.com.

C. Rheem Manufacturing Company: www.rheem.com.

2.02 RESIDENTIAL ELECTRIC WATER HEATERS

A. Type: Automatic, electric, vertical storage.

B. Performance:
   1. As scheduled on plans.

C. Electrical Characteristics:
   1. As scheduled on plans.

D. Tank: Glass lined welded steel, thermally insulated with one inch thick glass fiber; encased in

corrosion-resistant steel jacket; baked-on enamel finish.

E. Controls: Automatic water thermostat with externally adjustable temperature range from 120 to 170 degrees F, flanged or screw-in nichrome elements, enclosed controls and electrical junction box and operating light.

F. Accessories: Provide:
1. Water Connections: Brass.
2. Dip tube: Brass.
3. Drain Valve.
4. Anode: Magnesium

2.03 COMMERCIAL ELECTRIC WATER HEATERS

A. Type: Factory-assembled and wired, electric, vertical storage.

B. Performance:
1. As scheduled on plans.

C. Electrical Characteristics:
1. As scheduled on plans.

D. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.

E. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.

F. Accessories: Provide:
1. Dip tube.
2. Drain Valve.
3. Anode: Magnesium.
4. Temperature and Pressure Relief Valve: ASME labelled.

G. Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gages.

H. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 Watts per square inch.

DIAPHRAGM-TYPE COMPRESSION TANKS

I. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible diaphragm sealed into tank, and steel legs or saddles. NSF listed.

J. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psig.

2.04 IN-LINE CIRCULATOR PUMPS

A. Manufacturers:
1. Armstrong Pumps Inc: www.armstrongpumps.com.
2. ITT Bell & Gossett: www.bellgossett.com.

B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.

C. Impeller: Bronze.

D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

E. Seal: Carbon rotating against a stationary ceramic seat.

F. Drive: Flexible coupling.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Pipe P&T relief valve to floor or exterior as appropriate for the job condition.

C. Coordinate with plumbing piping and related electrical work to achieve operating system.

D. Pumps:
   1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
   2. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
   3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION 22 30 00

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water closets.

B. Urinals.

C. Lavatories.

D. Sinks.

E. Service sinks.

F. Electric water coolers.

1.02 RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping.

B. Section 22 10 06 - Plumbing Piping Specialties.

C. Section 22 30 00 - Plumbing Equipment.

1.03 REFERENCE STANDARDS

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

B. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers.

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

D. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures; The American Society of Mechanical Engineers.

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

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

1.04 SUBMITTALS

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

B. Manufacturer's Instructions: Indicate installation methods and procedures.

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.

1.05 QUALITY ASSURANCE

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

1.06 REGULATORY REQUIREMENTS

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

1.07 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.

1.08 WARRANTY

A. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 FLUSH VALVE WATER CLOSETS

A. Fixture to be as specified on plan.

B. Water Closets: Vitreous china, ASME A112.19.2, wall mounted, siphon jet flush action, with chair carriers, hardware, connection nipple as required for configuration and application.
   1. Bowl: ASME A112.19.2; 16.5 inches high with elongated rim.
   2. Flush Valve: Exposed (top spud).
   3. Flush Operation: Manual, oscillating handle.
   4. Handle Height: 44 inches or less.
   5. Color: White.
   6. Manufacturers:
      a. American Standard: www.americanstandard-us.com.
      b. Eljer www.eljer.com
      c. Kohler Company: www.kohler.com.
      d. Zurn Industries, Inc: www.zurn.com.

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   1. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
   2. ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, escutcheon, seat bumper, integral screwdriver stop and vacuum breaker; maximum 1.6 gallon flush volume. ADA compliant handle. Handle to be mounted on the access side of the water closet for H.C. accessible stalls (handle on the "wide" side of the stall).

D. Seats:
   1. Manufacturers:
      a. American Standard, Inc: www.americanstandard-us.com.
      b. Bemis Manufacturing Company: www.bemismfg.com.
      c. Church Seat Company: www.churchseats.com.
      d. Olsonite: www.olsonite.com.
      e. Zurn Industries, Inc: www.zurn.com.
   2. Solid white plastic, open front, extended back, brass bolts, without cover.

2.02 WALL HUNG URINALS

A. Wall Hung Urinal Manufacturers:
   1. American Standard: www.americanstandard-us.com.
   2. Eljer: www.eljer.com.
   3. Kohler Company: www.kohler.com.
   4. Zurn Industries, Inc: www.zurn.com.

B. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
   1. Flush Volume: 0.125 gallon, maximum.
   2. Flush Style: Washout.
   3. Flush Valve: Exposed (top spud).
   4. Flush Operation: Sensor operated.
   5. Trap: Integral.
   6. Removable stainless steel strainer.
   7. Supply Size: 3/4 inch.
   8. Outlet Size: 2 inches.

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor and over-ride push button.
   2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.

D. Fixture to be as specified on plan.

2.03 LAVATORIES

A. Lavatory
   Manufacturers:
   1. American Standard: www.americanstandard-us.com.
   2. Eljer: www.eljer.com
   3. Kohler Company: www.kohler.com.
   4. Zurn Industries, Inc: www.zurn.com.

B. Cast Iron Wall Hung Basin: ASME A112.19.1; porcelain enamelled cast iron wall-hung lavatory,

19 by 17 inch minimum, with 4 inch high back, drillings on 4 inch centers, rectangular basin with splas17h lip, front overflow, and soap depression.

C. Vitreous China Counter Top Basin: ASME A112.19.2; vitreous china self-rimming counter top lavatory, oval drop in with drillings on 4 inch centers, front overflow, soap depression, seal of putty, calking, or concealed vinyl gasket.

D. Fixture to be as scheduled on plan and furnished with wall bracket faucet, waste outlet, tailpiece, p-trap water supply tubing and stops.

E. Supply Faucet Manufacturers:
   1. Chicago Faucets
   2. Delta Faucets
   3. Sloan

F. Metered Faucet: ASME A112.18.1; chrome plated metered mixing faucet with battery operated solenoid operator and infrared sensor, aerator and cover plate, open grid strainer.

G. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
   1. Spout Style: Standard.
   2. Power Supply: 24 VAC.
      a. Direct wired to junction box.
      b. For 24V applications, provide transformer.
   3. Mixing Valve: Internal, automatic.
   4. Water Supply: 3/8 inch compression connections.
   5. Aerator: Vandal resistant, 0.5 GPM, laminar flow device.
   6. Automatic Shut-off: 30 seconds.
   7. Finish: Polished chrome.
   8. Accessory: 4 inch deck plate.
   9. Lead Content: Extra low; maximum 0.25 percent by weighed average.
   10. Sensor Operated Faucet Manufacturers:
      a. American Standard, Inc: www.americanstandard-us.com.
      b. The Chicago Faucet Company: www.chicagofaucets.com.
      c. Moen Incorporated: www.moen.com.
      d. Sloan Valve Company: www.sloanvalve.com.
      e. Toto USA;: www.totousa.com.
      f. Zurn Industries, Inc: www.zurn.com.

H. Accessories:
   1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
   2. Offset waste with perforated open strainer.
   3. Screwdriver stops.
   4. Rigid supplies.

2.04 SINKS

A. Sink Manufacturers:
   1. American Standard, Inc: www.americanstandard-us.com.
   2. Eljer.
   3. Kohler Company: www.kohler.com.

B. Single Compartment Bowl: ASME A112.19.3; X by X by X inch outside dimensions 20 gage thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
   1. Drain: 1-1/2 inch chromed brass drain.
   2. Drain: 3-1/2 inch crumb cup and tailpiece.

C. Double Compartment Bowl: ASME A112.19.3; X by X by x inch outside dimensions 20 gage thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
   1. Drain: 1-1/2 inch chromed brass drain for each bowl.
   2. Drain: 3-1/2 inch crumb cup and tailpiece for each bow..

D. Fixture to be as specified on plan.

E. Trim:
   1. Trim: ASME A112.18.1M; chrome plated brass supply with swing spout, vandal proof water economy aerator with maximum 2.2 gpm flow, single lever handle.

2.05 ELECTRIC WATER COOLERS

A. Electric Water Cooler Manufacturers:
   1. Tri Palm International/Oasis: www.tripalmint.com.
   2. Elkay Manufacturing Company: www.elkay.com.
   3. Haws Corporation: www.hawsco.com.

B. Fixture to be as specified on plan.

C. Fountain:
   1. Water Cooler: Electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
   2. Capacity: 8 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
   3. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.
   4. Cane Detection Apron: Installed to lower the high-bowl side body to cane detection maximum height.

2.06 SERVICE SINKS

A. Bowl: 24 by 24 by 10 inch high white molded stone, floor mounted, with one inch wide shoulders, vinyl bumper guard, stainless steel strainer.

B. Trim: ASME A112.18.1 exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.

C. Wall guard: Polished stainless steel wall guards installed at top of basin to protect wall finish from splashing.

D. Wall shelf and mop bracket: Furnished with fixture and installed on wall above basin so that water from wet mops will drain into the basin.

E. Hose and hose clamp hangar: 5' of flexible hose with wall mounted self gripping hanger to hold end of hose. Install on wall near faucet.

F. Fixture to be as specified on plan.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

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

3.03 INSTALLATION

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

B. Provide chrome plated rigid brass 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. Seal fixtures to wall and floor surfaces (as applicable) with mildew resistant silicone based sealant to match the fixture color. Do not use clear sealant to seal plumbing fixtures.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

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

3.05 ADJUSTING

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

3.06 CLEANING

A. Clean plumbing fixtures and equipment.

3.07 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.

3.08 SCHEDULES

A. Fixture Heights: Unless detailed otherwise on the plan, install fixtures to heights above finished floor as indicated.
   1. Water Closet:
      a. Standard: 15 inches to top of bowl rim.
      b. Accessible: 18 inches to top of seat.
   2. Water Closet Flush Valves:
      a. Standard: 11 inches min. above bowl rim.
   3. Urinal:
      a. Standard: 22 inches to top of bowl rim.
      b. Accessible: 17 inches to top of bowl rim.
   4. Lavatory:
      a. Standard: 31 inches to top of basin rim.
      b. Accessible: 34 inches to top of basin rim.
   5. Drinking Fountain & Water Cooler:
      a. Standard Adult: 40 inches to top of basin rim.
      b. Accessible: 36 inches to top of spout.

B. Fixture Rough-In
   1. Fixture rough-ins to be as specified on plan in the "PLUMBING FIXTURE CONNECTION SCHEDULE".

END OF SECTION 22 40 0

SECTION 23-05-10

COMMON MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General project related items that apply to all Division 23 sections. The provisions included in this section are complementary to and amendatory of the Division 1 sections of these project specifications - they do not replace them.

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to this section. Where conflicts may exist between Division 1 Specifications Sections and Division 23 Specification Sections, the Division 1 provisions shall take precedence except for when the Division 23 provisions expand, enhance, or extend the project, material or equipment requirements.

B. Applicable Division 26 specifications as applicable to wiring of final equipment connections.

1.03 REFERENCES

A. FM P7825 - Approval Guide; Factory Mutual.

B. NEMA MG 1 - Motors and Generators.

C. NFPA 70 - National Electrical Code.

D. SSPC-Paint 15 - Steel Joist Shop Paint; Steel Structures Painting Council.

E. North Carolina State Building Code (All Volumes)

1.04 DEFINITIONS

A. Building Code: Collectively, the current editions of all applicable codes whose requirements must be met in order for the Building Owner to be granted an Occupancy Permit by the authorities having jurisdiction over the building. These codes shall include but not be limited to the following specific volumes as well as any additional codes or standards referenced in these publications:
   1. General Construction.
   2. Administrative.
   3. Accessibility.
   4. Plumbing.
   5. Mechanical.
   6. Electrical.
   7. Fire Prevention.
   8. Fuel Gas.
   9. Energy Conservation.

B. Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing work or offering to perform work. The term "Contractor" shall apply to such entity regardless of whether the entity is working as a Prime Contractor or as a Sub Contractor on the project.
   1. Prime Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing or offering to perform work and who is awarded a contract with the Owner for work on this project.
   2. Sub Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing or offering to perform work and who is working on the project under contract with a Prime Contractor.

C. Collectively, the current editions of all applicable laws whose requirements must be met in order for the Building Owner to provide access to the public and to occupy and conduct business lawfully including any additional laws, codes or standards referenced in these laws. These laws include but are not limited to the following:
   1. Americans With Disabilities Act.

2. Energy Policy Act.

D. Provide: When used in these specifications or on the drawings, the term "provide" shall mean to furnish, install, and adjust as required for safe and efficient operation.

E. Supply: When used in these specifications or on the drawings, the term "supply" shall mean to furnish with all required appurtenances for a complete installation and advise the installing contractor on details relating to the installation as needed.

1.05 GENERAL PROJECT REQUIREMENTS

A. The plans and specifications for this project are prepared to represent the general project requirements and intent. They are diagrammatic in nature and are not intended to show each and every fitting, offset, or other modifications or minor devices that may be required in the field to provide a complete system that is safe, efficient and effective in operation. Minor components or modifications that are required to provide a safe, efficient and effective system shall be included in the bid price whether or not they are specifically called for on the plans or in these specifications. It is understood that the contractors bidding this project are required to be licensed in their respective trade and are therefore knowledgeable in the trade in which they are licensed.

B. The Contractor shall provide all contingencies and supply all tools, fixtures, transportation, etc. as well as materials necessary for installation. In all its details, the work and materials shall be subject to the approval of the Architect or Engineer whose decision on all points of difference shall be final and binding on this Contractor.

C. The Contractor shall secure and pay for all necessary approvals, permits, inspections, certificates etc.. required by state or local codes or statutes, rules, or regulations and pay all fees required unless specifically noted otherwise.

D. All work and materials are required to be in compliance with State and Local Codes. Any conflicts between the plans and State or Local Codes, Rules, Statutes, or Regulations shall be brought to the Architect's or Engineer's attention in writing immediately.

E. Plans are diagrammatic in nature and show the general design and arrangement of the systems. They are not intended to show each and every offset or fitting required for installation of work under this contract. This Contractor, as a licensed professional, is required to be proficient and knowledgeable in his trade and is required to include all such items and contingencies in his bid. The plans are not to be scaled for rough-in dimensions nor are they to be used for shop drawings.
   1. Where dimensions are given on the plans, they must be verified with actual field measurements taken on the project site. This Contractor shall take such field measurements as required to coordinate the installation of his work or to prepare shop drawings.
   2. Slight relocation of fixtures, equipment, devices and other items may be made by this Contractor as required to fit his work to casework, trim, brick coursing, etc. as long as such relocation does not interfere with work of any other Contractor.

F. Cutting, patching and firestopping for all work under this contract will be the responsibility of the installing contractor. Holes shall be cut in walls, floors, ceilings, etc. as required for installation of materials, access for installation of materials - or other reasons as may require cutting - by this contractor for all of his work. Patching holes and spaces around installed materials or equipment shall also be by this contractor.
   1. All penetrations through walls, floors, ceilings, etc. shall be sealed. Leave all patched surfaces in exposed locations ready for application of final finishes. Leave patched surfaces in concealed locations neat in appearance and continuous around all sides of the penetration.
   2. For non-rated partitions, seal with caulk, grout or other approved material that is appropriate for the substrate that the patch is matched to. For 1 hour rated partitions, seal with approved non-combustible materials as listed in the State Building Code. For penetrations in partitions with fire resistance ratings in excess of 1 hour, firestop penetrations with UL listed firestopping assemblies approved for the penetrating materials as well as the partition type and materials.

G. Provide starters for equipment supplied under this contract that requires starters unless the starters are scheduled to be a part of a motor control center. Refer to applicable Division 26 drawings and specification sections for starter requirements.

H. Provide variable speed drives for equipment supplied under this contract that require variable speed drives. Refer to applicable Division 26 drawings and specifications sections for variable speed drive requirements.

1.06 COORDINATION OTHER DIVISIONS (AND COORDINATION DRAWINGS)

A. Requirements noted in this division are intended to be supplementary to Division 1 requirements. Where Division 1 requirements exceed the requirements in this section, the Division 1 requirements shall govern. Where requirements in this section exceed Division 1 requirements, the requirements in this division shall govern. This Contractor is required to review the Division 1 requirements as well as other Divisions to allow coordination of his work with other trades.

B. Coordinate with Division 26 contractor to locate point of electrical connection for each piece of equipment and to identify location for point of demarcation from Division 26 contractor wiring.

1.07 PERFORMANCE REQUIREMENTS

A. All equipment installed in fire rated walls, ceilings, or other partitions shall be listed to maintain the fire rating and shall be installed to maintain the rating.

B. Materials (such as conduit, pipes, ducts, etc..) passing through fire rated walls, ceilings or other partitions shall be suitably firestopped using only approved materials and methods to maintain the fire rating of the assembly.

C. Schedule all required inspections by State and Local Authorities, and make all corrections as required by such inspections.

1.08 SUBMITTALS

A. Submit Coordination Drawings in accordance with Division 1 requirements.

B. Shop Drawings: Submit shop drawings as specified in the respective specification section. When equipment, materials or systems other than the one specified are submitted, this Contractor shall be required to clearly mark differences between the items submitted and the items specified. This Contractor shall be responsible for all changes required (including but not limited to piping, wiring, mounting, clearances, etc.) under this and other divisions due to the use of items other than those specified.
   1. Submit shop drawings in one complete package and not at intervals.
   2. The Contractor shall check each submittal for accuracy and completeness prior to submitting the shop drawings to the Engineer. The Contractor shall stamp and sign the documents accordingly
   3. Each item being submitted for review shall be clearly identified in the submittal. In the event that multiple items are cataloged in a section and a single item is not clearly identified as the one that is being submitted, the Engineer may at his discretion select any suitable item from the page that meets or exceeds the requirements for the project.

C. Operation and Maintenance Manuals: Submit quantities as required in Division 1 sections (but not less than 3 sets) bound and tabbed in three ring binders with the project name, the contractors name and contact information and relevant installation, operating and maintenance data for all equipment installed on the project.

1.09 QUALITY ASSURANCE

A. Perform in accordance with state and local building codes, laws and ordinances.

B. Obtain and pay for all inspections, permits, and fees required for work under this contract.

C. Substitutions: Substitutions shall be made in accordance with the procedures given in the applicable Division 1 sections. The following procedures shall supplement the procedures given in Division 1. In the event that there are not substitution procedures given in Division 1, these procedures shall be used for all Division 23 and Division 26 items.
   1. When equipment, materials or systems other than the one specified are submitted, this Contractor shall be required to clearly mark differences between the items submitted and the items specified. This Contractor shall be responsible for all changes required (including but not limited to piping, wiring, mounting, clearances, etc.) under this and other divisions due to the use of items other than those specified. The costs for these required changes shall be borne by the Contractor making the

substitution at no additional costs to the Owner. The Engineer's decision on the acceptability of substitute equipment shall be final and binding under this contract. The acceptance of substitute items shall in no way relieve the Contractor from meeting any of the project requirements.

2. Items that are to be substituted for a specified item shall be equal in quality, performance, capacity, size, construction, utility requirements, appearance, etc. to the item specified.
3. Substitutions may be made for all items specified using the term "or equal". Where an item is specified without the use of the term "or equal" that item must be used for the project bid. No substitutions may be made for items that are specified without the "or equal" term.
4. Items exceeding the performance, efficiency, quality, etc. may be used when approved by the Engineer, but no additional money will be paid under the contract for such features.
5. The Engineer may consider qualities and characteristics of the specified item which may or may not have been specifically called out in the schedules or specifications when evaluating the suitability of a substitute item. The Engineer's decision regarding the acceptability of substitute items shall be final and binding under this contract.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience and properly licensed to perform the work.

E. Install equipment to comply with the Americans With Disabilities Act requirements.

F. Pressure test piping systems prior to insulating or introducing system fluid, fuel gas etc. into piping system. Isolate equipment, pressure relief valves, and other specialty items that could be damaged by the test pressures. Conduct tests utilizing a chart recording device to record the piping system pressure for a period of not less than 8 hours. Provide all fittings, valves, installation and removal as required to pressurize the system and connect pressure probes to the system. Submit pressure test charts with annotated with the system tested, the test date, and the person performing the testing. Test systems as follows:

1. Fuel Gas Piping: Pressurize to 100 psi air pressure. Soap joints and check for leaks. Repair as necessary and retest. After all leaks have been repaired, pressurize system and record pressure for test period. Pressure shall not decrease more than 10% during the testing period. If drastic temperature changes influence the test, repeat the testing when temperatures are not expected to change drastically.
2. Hydronic Piping: Fill with water and pressurize to 125 psi using municipal water pressure if possible. Transfer pumps or compressed air may be used to surcharge the pressure if municipal water pressure is unavailable or inadequate. Pressure shall not decrease more than 10% over a 24hr. period.

1.10 DELIVERY, STORAGE, AND PROTECTION

A. Store materials and equipment under cover and elevated above grade until ready for installation.

B. Deliver materials and products to project site in their original shipping containers.

1.11 PROJECT CONDITIONS

A. Coordinate new work installation with size, location and installation of any existing service utilities. Field verify all locations of utilities prior to beginning work and as necessary during project progress.

B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.12 WARRANTY

A. See Division 1 Section - Closeout Submittals, for additional warranty requirements.

B. All labor, materials, and products supplied on this project shall have a minimum of 1 year parts and labor replacement warranty. Provide an additional 4 years parts warranty for all refrigerant compressors.

C. Consult individual specification sections for additional warranty requirements. Warranty requirements stated in the subsequent specifications sections are supplemental to requirements in this warranty section.

D. Correct defective Work within a one year period after Date of Substantial Completion unless a different date is given in Division 1 specifications sections. Provide all materials, labor, supplies etc. as required to remove, disassemble, replace, reassemble, etc. the failed or otherwise defective parts that are covered under the warranty terms.

E. Provide five year manufacturer warranty for parts of all compressors.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials and equipment supplied on this project shall comply with the applicable standards for the material or equipment where such standard exists. All items shall be listed by Underwriters Laboratories or other approved third party listing agency where a listing is available.

B. All materials and equipment used on the project shall be new unless specifically specified otherwise in the Project Plans or Specifications.

C. All equipment used on the project shall be the latest current production model available at the time of bidding. No discontinued, superseded, suspended production models or otherwise obsolete equipment shall be used on this project. In the event that equipment is discontinued, superseded, or production is suspended on the models bid, current production models shall be substituted and so noted on the shop drawing submittals.

D. All materials and equipment shall be in accordance with the North Carolina State Building Code (all volumes), local codes and ordinances and shall be approved for the intended use on the project.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are proper for the installation of material or equipment prior to installing such equipment. Correct (or have corrected) any unsatisfactory conditions prior to installing materials or equipment.

3.02 INSTALLATION

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations. Supply additional materials and labor as may be recommended by the manufacturer or where required for compliance with codes for the best installation of the materials or equipment whether such items are specifically called for otherwise in the project plans or specifications.

B. Unless specifically shown otherwise on the plans, install all piping, ductwork, etc. concealed from view of finished spaces.

C. Coordinate rough-in of plumbing fixtures, thermostats, etc. with the requirements of the Americans With Disabilities Act requirements.

D. Install all equipment, materials, components, etc. in accordance with the applicable Building Code requirements and Building Related Laws. The project plans and specifications are prepared with the knowledge that bidders must be licensed contractors in their respective trade, and as such, are required to be knowledgeable of code and law requirements. All materials, components, accessories or other appurtenances required by code or law for a proper, safe, efficient, and legal installation shall be included in the project base bid price. Any and all work, materials, equipment, supplies or other items made necessary by code or law requirements shall be included in the project base bid price whether or not said items are specifically called for on the project plans or in the specifications. No additional charges shall be allowed to the contract for items that are legally required by such code or laws.

E. Provide additional intermediate steel members and attach the steel to the building structure as required to provide structurally sound point of attachment for piping and equipment supports. Install intermediate steel at approved panel points on bar joists. Do not attach to cross bracing that is attached to bar joists. Attach to bar joists at panel points only. Do not attach to bar joists at any point or in any manner that is not approved by the bar joist manufacturer. Paint all bare steel surfaces of supporting steel. Relocate all attachments that are found to be made in unapproved locations.

3.03 INTERFACE WITH OTHER WORK

A. This Contractor shall coordinate his work with that of all other Contractors on the project and shall consult the drawings and specifications of the other trades to determine the nature and effect of work by others. This Contractor shall be responsible for all his work fitting in place with in an approved manner, and shall consult with others as required for drawings, dimensions, elevations, actual building

measurements, etc. as necessary to ensure that his work does fit properly and does not conflict with other trades.

B. In the event that interferences develop, this Contractor shall cooperate with others to eliminate the interference. Should pipes, ductwork, conduit, equipment or other items have to be relocated, the Architect's or Engineer's decision will be the final authority as to which Contractor shall relocate his work.

C. Coordinate voltage and current characteristics of all equipment installed with other Contractors, Subcontractors or Owner on the project.

D. Coordinate the power connections for all equipment installed by this Contractor with other Contractors on the project.

E. Do not route pipes conveying water, sewer, gas or other medium over electrical panelboards.

3.04 FIELD QUALITY CONTROL

A. Thoroughly inspect equipment installed on this project for proper installation prior to start-up of the equipment.

B. Adjust and test each piece of equipment to ensure that all operating and safety controls are functioning safely, properly and efficiently. Replace any defective items that would prevent such operations.

3.05 STARTING EQUIPMENT AND SYSTEMS

A. Do not operate the permanent building heating, cooling or ventilation systems before building construction activities that generate dust, flyings or other debris are completed and the building has been cleaned to a "broom clean" condition. Do not operate the permanent building systems at any time before the building is in a cleaned condition without temporary filters installed over return and exhaust inlets to prevent entry of construction dirt into the systems. Remove all temporary filters upon completion of the facility. Any coils, fans, ducts, plenums, air inlets, air outlets, or other equipment in the airstream found to have an accumulation of dirt shall be cleaned by the contractor prior to Owner acceptance of the facility.

B. Provide manufacturer's field representative to prepare and start major equipment such as boilers, chillers, condensing units larger than 25 tons, water heaters in excess of 60,000 btuh, variable frequency drives, energy recovery equipment, and air handling units larger than 10,000 cfm.

C. Adjust for proper operation within manufacturer's published tolerances.

D. Demonstrate proper operation of systems to Owner's designated representative and instruct him in the proper maintenance procedures of each system.

3.06 ADJUSTING

A. Adjust equipment for smooth, quiet, safe and efficient operation.

3.07 CLEANING

A. Clean all equipment, piping, ductwork, labels, mechanical rooms, attics etc. prior to project closeout. All construction debris is to be removed and properly disposed of. Remove all stains and drips from the equipment and from the building.

B. Protect installed material and equipment from subsequent construction operations.

C. Do not permit traffic over unprotected floor surface.

END OF SECTION 23-05-10

SECTION 23-05-13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

1.02 RELATED REQUIREMENTS

A. Section 26-05-83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.

C. NEMA MG 1 - Motors and Generators.

D. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

C. Operation Data: Include instructions for safe operating procedures.

D. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

B. Conform to NFPA 70.

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 5 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lincoln Motors: www.lincolnmotors.com.

B. A. O. Smith Electrical Products Company: www.aosmithmotors.com.

C. Reliance Electric/Rockwell Automation: www.reliance.com.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:

1. As scheduled for each piece of equipment.

a. Voltage listed in schedules is the nominal electrical system supply voltage. Motor must be rated for the system supply voltage and must be rated for operation at plus or minus 10% of the rated voltage.

b. Statements such as “Suitable for use” at a specific voltage on the nameplate will identify that the motor is not rated for use on that voltage and is therefore not a suitable application for the listed voltage as a system voltage.

B. Nominal Efficiency:
1. Comply with federal laws and state codes for efficiency requirements.

C. Construction:
1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Terminals shall be rated for min 75C temperature rise. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

F Shaft Grounding:
1. Motor shaft must be equipped with shaft grounding means to prevent motor bearing failures due to VFD induced bearing currents. Shaft grounding is required for all motors whether initially controlled by VFD or not due to the likelihood that a VFD may later be applied to control the motor operation.

G. Inverter Duty Rated:
1. Motors shall be constructed to withstand voltage spikes produced by VFD control and rated for VFD compatibility. Inverter Duty Rating is required for all motors whether initially controlled by VFD or not due to the likelihood that a VFD may later be applied to control the motor operation.

2.03 APPLICATIONS

A. Single phase motors for shaft mounted fans, oil burners, and centrifugal pumps: Split phase type.

B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

C. Single phase motors for fans, pumps, and blowers: Capacitor start type.

D. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

E. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

F. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26-29-13.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.

K. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

M. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

N. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate. Insure that voltage is at least 10% above XXX value if the statement “Suitable for use at XXX Volts” is present on nameplate. Motor must be replaced with suitable system voltage rated motor if needed.

D. Check for proper rotation direction and adjust phase wiring connections if incorrect.

E. Check for proper amp draw and insure any overloads are properly sized for the motor.

F. Check for unusual sounds or vibrations. Repair source if any found.

G. Check for proper operating temperature rise. If rise exceeds anticipated amount, troubleshoot and repair or replace motor as required.

END OF SECTION 23-05-13

SECTION 23-05-53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive Labels.

D. Stencils.

E. Pipe markers.

F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

A. Section 09-91-23 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS

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

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

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

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

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Air Terminal Units: Nameplates.

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

D. Control Panels: Nameplates.

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

F. Ductwork: Stenciled painting.

G. Heat Transfer Equipment: Nameplates.

H. Instrumentation: Tags.

I. Major Control Components: Nameplates.

J. Piping: Pipe markers.

K. Pumps: Nameplates.

L. Relays: Nameplates or machine printed adhesive labels.

M. Small-sized Equipment: Tags.

N. Tanks: Nameplates.

O. Thermostats: Machine printed adhesive labels.

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

Q. Water Treatment Devices: Nameplates.

2.02 MANUFACTURERS

A. Brady Corporation: www.bradycorp.com.

B. Champion America, Inc: www.Champion-America.com.

C. Seton Identification Products: www.seton.com/aec.

2.03 NAMEPLATES

A. Manufacturers:
   1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
   2. Brimar Industries, Inc.: www.pipemarker.com.
   3. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
   4. Seton Identification Products: www.seton.com.

B. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.
   2. Background Color: Black.

2.04 TAGS

A. Manufacturers:
   1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
   2. Brady Corporation: www.bradycorp.com.
   3. Brimar Industries, Inc.: www.pipemarker.com.
   4. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
   5. Seton Identification Products: www.seton.com.

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

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.05 ADHESIVE LABELS

A. Commercial grade labels with bold black letters. Labels shall be machine printed with a commercial grade label maker. Labels shall be water resistant mylar film and lettering shall be permanently impregnated into the label so that it does not flake or peel off from the base material. Labels shall have fully adhesive coated back. Letter and numbers shall be printed in a bold font. Labels shall be of the following minimum widths and colors.
   1. 3/4" wide with 1/2" high black letters for labels affixed to thermostats and items smaller than thermostats.
   2. 1" wide with 3/4" high black letters for labels affixed to ceilings and to items larger than thermostats
   3. Background colors as follows:
      a. Clear background for controls components.
      b. Green color background for plumbing components.
      c. Blue color background for HVAC valves.
      d. Yellow color background HVAC equipment.
      e. Red color background for fire dampers, smoke dampers, etc.

2.06 STENCILS

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.
   4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
   5. Ductwork and Equipment: 2-1/2 inch high letters.

2.07 PIPE MARKERS

A. Color: Conform to 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.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.08 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.
   3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners (screws or rivets). Adhesives may be used as supplemental fixation, but mechanical fasteners will still be required to ensure the nameplates are permanently secured.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09-91-23.

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

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

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, chillers, boilers, miscellaneous heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify thermostats relating to terminal boxes or valves with nameplates or clear labels with black letters.

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

K. Identify air terminal units valves with nameplates.

L. Tag or label automatic controls, instruments, and relays. Key to control schematic.

M. Paint all gas piping and fittings with 2 coats of safety yellow oil based enamel semi-gloss paint for easy identification.

N. Paint exposed hydronic piping insulation systems with 2 coats of paint in accordance with the following color code:
   1. Chilled Water Piping: Light Blue
   2. Hot Water Piping: Light Red
   3. Makeup Water Piping: Dark Blue

O. Paint pipe insulation shields and pipe hangers that are exposed to match the piping supported.

P. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, and flow direction. Install in clear view and align with axis of piping. Locate identification not to exceed 12 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.

Q. Install ductwork with stenciled painting. 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.

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

S. Provide adhesive labels secured to t-bar grid to identify the specific component located above the tack by its unique identifier number listed in the valve schedule, equipment schedule, or other tabulation of components. Attach the label to the bottom of the grid nearest the ceiling tack. Insure full adhesion of the label to the grid.

END OF SECTION 23-05-53

SECTION 23-05-93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

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

B. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

A. AABC MN-1 - AABC National Standards for Total System Balance.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.

1.03 SUBMITTALS

A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Procedures for formal deficiency reports, including scope, frequency and distribution.

B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Revise TAB plan to reflect actual procedures and submit as part of final report.
   2. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
   4. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
   5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   7. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
   8. Include detailed procedures, agenda, sample report forms prior to commencing system balance.
   9. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE Std 111, or NEBB forms.
   10. Include the following on the title page of each report:
      a. Project name.
      b. Project location.
      c. Project Engineer.
      d. Project Engineer.
      e. Project Contractor.
      f. Project altitude.
      g. Report date.

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

1.04 QUALITY ASSURANCE (MOVED TO PART 3)

A. Perform total system balance in accordance with AABC MN-1, ASHRAE Std 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.05 SEQUENCING AND SCHEDULING (MOVED TO PART 3)

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:

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

C. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section. TAB agency shall be certified by either AABC or NEBB. The TAB contractor shall be a subcontractor to the Mechanical Contractor.

3.02 EXAMINATION

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

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

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

A. Hydronic Systems: Adjust to within plus or minus 5 percent of design.

3.05 RECORDING AND ADJUSTING

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

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

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

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

3.06 WATER SYSTEM PROCEDURE

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

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

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

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

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

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

3.07 SCOPE

A. Test, adjust, and balance the following:
   1. HVAC Packaged Units.
   2. Fans
   3. Packaged Wall Mounted Heat Pumps.
   4. Air distribution system supply, return, exhaust grilles registers and diffusers.

END OF SECTION 23-05-93

SECTION 23-07-13

DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

C. Insulation jackets.

1.02 REFERENCE STANDARDS

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

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

C. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.

D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

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

F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 JACKETS

A. Aluminum Jacket: ASTM B209 (ASTM B209M).
   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.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.03 DUCT LINER

A. Manufacturers:
   1. Knauf Insulation: www.knaufinsulation.com.
   2. Johns Manville: www.jm.com.
   3. Owens Corning Corporation: www.ocbuildingspec.com/sle.
   4. CertainTeed Corporation: www.certainteed.com.

B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
   1. Fungal Resistance: No growth when tested according to ASTM G21.
   2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
   3. Service Temperature: Up to 250 degrees F.
   4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
   5. 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, impact applied, or welded with integral head.

E. Greenguard Certified for Schools.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated ducts conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

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

E. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
   3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
   4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

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.

END OF SECTION 23-07-13

SECTION 23-07-19

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jackets and accessories.

1.02 RELATED REQUIREMENTS

A. Section 09-91-23 - Interior Painting: Painting insulation jacket.

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

1.03 REFERENCE STANDARDS

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

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

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

D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

G. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

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

J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

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

B. Samples: Submit two samples of any representative size illustrating each insulation type.

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

1.05 QUALITY ASSURANCE

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

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

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com.
   2. Johns Manville Corporation: www.jm.com.
   3. Knauf Insulation: www.knaufinsulation.com.
   4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com.

B. 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.

C. 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.

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

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5 by 5.

H. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

I. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

K. Insulating Cement: ASTM C449.

2.03 CELLULAR GLASS

A. Insulation: ASTM C552, Type II.
   1. 'K' Value: Grade 6, 0.35 at 100 degrees F.
   2. Service Temperature: Up to 800 degrees F.
   3. Water Vapor Permeability: 5 perm inch .
   4. Water Absorption: 0.5 percent by volume, maximum.

2.04 JACKETS

A. PVC Plastic.
   1. 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.

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; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

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

D. Insulated pipes conveying fluids below ambient temperature; 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. Finish with glass cloth and adhesive or PVC fitting covers.

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

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to firestopping details.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

L. 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.

M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return:
      a. Pipe Sizes 1/2" to 1.5"
         1) 1" wall thickness glass fiber pipe insulation with all service jacket.
      b. Pipe Sizes 2" and larger
         1) 2" wall thickness glass fiber pipe insulation with all service jacket.

B. Cooling Systems:
   1. Chilled Water Supply and Return:
      a. Pipe Sizes 1/2" to 1.5"
         1) 1" wall thickness glass fiber pipe insulation with all service jacket.
      b. Pipe Sizes 2" and larger
         1) 2" wall thickness glass fiber pipe insulation with all service jacket.
   2. Condensate Drains from Cooling Coils:
      a. Pipe Sizes 1/2" to 3"
         1) 1" wall thickness glass fiber pipe insulation with all service jacket.

C. Other Systems:
   1. Piping Exposed to Freezing with Heat Tracing:
      a. Pipe Sizes 1/2" to 1.5"
         1) 1.5" wall thickness glass fiber pipe insulation with all service jacket and aluminum jacket cover.
      b. Pipe Sizes 2" and larger
         1) 2" wall thickness glass fiber pipe insulation with all service jacket and aluminum jacket cover.

D. Refrigerant Gas Piping:
   1. Interior piping not exposed to sunlight:
      a. Pipe Sizes 1/2" to 1.5"
         1) 1/2" wall thickness flexible unicellular with all joints and seams sealed. Use seamless tubing for new piping.
   2. Exterior piping exposed to sunlight or weather conditions:
      a. Pipe Sizes 1/2" to 1.5"
         1) 1/2" wall thickness flexible unicellular with all joints and seams sealed. Use seamless tubing for new piping.
         2) Paint exposed piping with latex paint per manufacturer's instructions to protect from UV degradation.
         3) Provide metal cover to match color of downspout material to cover exposed piping installed on exterior wall.

END OF SECTION 23-07-19

SECTION 23-31-00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.

B. Duct cleaning.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.04 QUALITY ASSURANCE

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

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

1.05 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.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.

B. Ducts: Galvanized steel, unless otherwise indicated.

C. Low Pressure Supply (Heating Systems): 1/2 inch w.g. pressure class, galvanized steel.

D. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. pressure class, galvanized steel.

2.02 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

B. 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. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
3. For Use With Flexible Ducts: UL labeled.

C. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.03 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.

C. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

D. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

E. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.

F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

G. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

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.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
   1. Manufacture in accordance with SMACNA (DCS).
   2. Insulation:
      a. Thickness: 1 inch.
      b. Material: Fiberglass.

B. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
   1. Insulation: Fiberglass insulation with aluminized vapor barrier film.
   2. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
   3. Maximum Velocity: 4000 fpm.
   4. Temperature Range: Minus 20 degrees F to 210 degrees F.

C. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

G. Use double nuts and lock washers on threaded rod supports.

H. Connect terminal units to supply ducts 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 with 5 feet maximum length of flexible duct held in place with strap or clamp.

J. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

K. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.02 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION 23-31-00

SECTION 23-33-00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backdraft dampers - metal.

B. Backdraft dampers - fabric.

C. Duct access doors.

D. Duct test holes.

E. Flexible duct connections.

F. Volume control dampers.

G. Miscellaneous products:
   1. Duct opening closure film.

1.02 RELATED REQUIREMENTS

A. Section 23-31-00 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

B. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS

A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 BACKDRAFT DAMPERS - METAL

A. Manufacturers:
   1. Louvers & Dampers, Inc: www.louvers-dampers.com.
   2. Nailor Industries Inc: www.nailor.com.
   3. Ruskin Company: www.ruskin.com.

2.02 BACKDRAFT DAMPERS - FABRIC

A. Fabric Backdraft Dampers: Factory-fabricated.
   1. Blades: Neoprene coated fabric material.
   2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
   3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.03 DUCT ACCESS DOORS

A. Manufacturers:
   1. Acudor Products Inc: www.acudor.com.
   2. Elgen Manufacturing: www.elgenmfg.com.
   3. Nailor Industries Inc: www.nailor.com.
   4. Ruskin Company: www.ruskin.com.
   5. SEMCO Incorporated: www.semcohvac.com.
   6. Ward Industries by Commercial Products Group of Hart & Cooley, Inc: www.wardind.com.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

2.04 DUCT TEST HOLES

2.05 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
   1. Carlisle HVAC Products: www.carlislehvac.com.
   2. Elgen Manufacturing: www.elgenmfg.com.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
      a. Net Fabric Width: Approximately 2 inches wide.
   2. Metal: 3 inches wide, 24 gage, 0.0239 inch thick galvanized steel.

D. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

E. Maximum Installed Length: 14 inch.

2.06 VOLUME CONTROL DAMPERS

A. Splitter Dampers:

2.07 MISCELLANEOUS PRODUCTS

A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
   1. Thickness: 2 mils.
   2. High tack water based adhesive.
   3. UV stable light blue color.
   4. Elongation Before Break: 325 percent, minimum.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23-31-00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

F. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

G. For fans developing static pressures of 5.0 inches and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Use splitter dampers only where indicated.

J. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23-33-00

SECTION 23-34-23

HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.

B. Wall exhausters.

C. Cabinet exhaust fans.

D. Ceiling exhaust fans.

1.02 RELATED REQUIREMENTS

A. Section 23-05-13 - Common Motor Requirements for HVAC Equipment.

B. Section 23-05-48 - Vibration Controls for HVAC Piping and Equipment.

C. Section 23-33-00 - Air Duct Accessories: Backdraft dampers.

D. Section 26-05-83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program.

B. AMCA 99 - Standards Handbook.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

I. UL 705 - Power Ventilators.

J. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of ventilators with size, location and installation of service utilities.

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

1.05 SUBMITTALS

A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

B. Manufacturer's Instructions: Indicate installation instructions.

C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 QUALITY ASSURANCE

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

1.07 FIELD CONDITIONS

A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Greenheck: www.greenheck.com.

B. Loren Cook Company: www.lorencook.com.

C. PennBarry: www.pennbarry.com.

2.02 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.

B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.

D. Fabrication: Conform to AMCA 99.

E. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

G. Enclosed Safety Switches: Conform to NEMA 250.

H. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.03 WALL EXHAUSTERS

A. Perfromance as scheduled on the plans.

B. Fan Unit: V-belt or direct driven with spun aluminum housing; resiliently mounted motor; 1/2 inch mesh, 0.062 inch thick aluminum wire bird screen.

C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor, and wall mounted multiple speed switch.

D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

E. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 CABINET EXHAUST FANS

A. Perfromance as scheduled on the plans.

B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.

C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.

D. Grille: Aluminum.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide curb adapters for fans that are to be installed on existing roof curbs.

C. Ceiling and cabinet fans:
   1. Support fans from structure with vibration isolation mounts. Do not attach directly to ceiling supports.
   2. Provide flexible duct connections to fans.
   3. Support ducts independent ot fans.

D. Provide sheaves required for final air balance.

E. Install backdraft dampers on inlet to roof and wall exhausters.

F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

G. Verify proper rotation of fans.

H. Verify vibration free operation of fans - repair any vibrations if present.

I. Verify smooth operation of fans. Make adjustments if required to eliminate rubbing or squeaking.

J. Tension belts on initial startup and re-tension after 10 hour of operation.

END OF SECTION 23-34-23

SECTION 23-37-00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.02 RELATED REQUIREMENTS

A. Section 09-91-23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

A. ADC 1062: GRD - Test Code for Grilles, Registers & Diffusers.

B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.

C. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets.

1.04 SUBMITTALS

A. 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.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 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.

1.06 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

2.01 MANUFACTURERS

A. Carnes, a division of Carnes Company Inc: www.carnes.com.

B. Krueger-HVAC, Division of Air System Components: www.krueger-hvac.com.

C. Price Industries: www.price-hvac.com.

D. Metalaire: www.metalaire.com

E. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com.

F. Tuttle and Bailey: www.tuttleandbailey.com.

2.02 RECTANGULAR CEILING DIFFUSERS

A. As scheduled on plans

2.03 CEILING SUPPLY REGISTERS/GRILLES

A. As scheduled on plans

B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, four-way deflection.

C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.

D. Construction: Made of aluminum extrusions with factory enamel finish.

E. Color: As indicated.

2.04 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. As scheduled on plans

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.

C. Frame: 1-1/4 inch margin with countersunk screw mounting.

D. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

E. Color: As indicated.

F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

G. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.05 WALL SUPPLY REGISTERS/GRILLES

A. As scheduled on plans

B. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.

C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.

D. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

E. Color: As indicated.

F. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

G. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.06 WALL SUPPLY REGISTERS/GRILLES

A. As scheduled on plans

B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.

C. Fabrication: Aluminum extrusions with factory off-white enamel finish.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.07 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. As scheduled on plans

B. Frame: 1-1/4 inch margin with countersunk screw mounting.

C. Fabrication: Aluminum extrusions, with factory off-white enamel finish .

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

PART 3 EXECUTION

3.01 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. Coordinate diffuser and grille locations with lights, ceiling speakers, occupancy sensors, smoke detectors, ceiling grids, etc. to eliminate conflicts. Where relocation from the location indicated on the plans is required, locate as close as possible and make modifications to other diffusers and grilles in the room to establish a uniform and symmetrical pattern.

C. Install diffusers to ductwork with air tight connection.

D. Provide rectangular to round transitions as required for diffusers with rectangular necks and round runouts.

E. 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.

F. Use dampers at diffusers and grilles only for fine balancing to reduce airflow by 10% or less. Use dampers at runout take-off for initial balancing and for all balancing requiring a flow reduction in excess of 10%.

G. Paint ductwork visible behind air outlets and inlets matte black.

H. Coordinate diffuser and grille type with the ceiling system. Provide plaster frame for devices in gypsum ceilings.

END OF SECTION 23-37-00

SECTION 23-40-00

HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disposable, extended area panel filters.

B. Disposable panel filters.

C. Filter frames.

D. Washable permanent panel filters.

E. Filter frames and housings.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

B. UL 900 - Standard for Air Filter Units.

1.04 SUBMITTALS

A. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

A. American Filtration Inc: www.americanfiltration.com.

B. AAF International/American Air Filter: www.aafintl.com.

C. Camfil Farr Company: www.camfilfarr.com.

2.02 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
   1. Frame: Cardboard.
   2. Nominal size: 12 by 24 inches.
   3. Nominal thickness: 1 inch.

B. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.

C. Rating, per ASHRAE Std 52.2:
   1. Weight arrestance: 85 percent.
   2. Initial resistance at 500 FPM face velocity: 0.20 inch WG.
   3. Recommended final resistance: 0.9 inch WG.

2.03 DISPOSABLE PANEL FILTERS

A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
   1. Nominal Size: 12 by 24 inches.
   2. Thickness: 1 inch.

B. Performance Rating:
   1. Face Velocity: 500 FPM.
   2. Initial Resistance: 0.15 inch WG.

C. Casing: Cardboard frame.

D. Minimum MERV Rating:
   1. Fan Coil Units, Unit Ventilators, Small Air Handling Units: MERV 8..
   2. Packaged Units, Built-up Air Handling Units, Larger Packaged Units as capable: MERV 11.

2.04 WASHABLE PERMANENT PANEL FILTERS

2.05 FILTER FRAMES AND HOUSINGS

A. General: Fabricate filter frames and supporting structures of 16 gage, 0.0598 inch galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.

B. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for 24 by 24 inches filter media, minimum 2 inches thick; for extended surface and high efficiency particulate air filters, provide for upstream mounting of panel filters.

C. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gage, 0.0598 inch galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extruded aluminum tracks or channels for primary secondary filters with positive sealing gaskets.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

D. Furnish air filters with all air handling units, fan powered VAV boxes, and other items noted to contain filters.

END OF SECTION 23-40-00

SECTION 23-74-14

PACKAGED WALL MOUNTED HEAT PUMP UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged wall mount unit.

B. Unit controls.

1.02 RELATED REQUIREMENTS

A. Section 26-05-83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment.

C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.04 SUBMITTALS

A. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

B. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

C. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

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

E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Filters: One set for each unit.

1.05 QUALITY ASSURANCE

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

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.07 WARRANTY

A. Provide a one year warranty to include parts and labor coverage for entire unit.

B. Provide an additional 4 year parts warranty for refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers offering products for consideration subject to meeting requirements and job conditions, include but are not limited to

1. Bard Manufacturing: www.bard.com.
2. Marvair: www.marvair.com.

2.02 PERFORMANCE REQUIREMENTS

A. Performance as scheduled on the drawings.

2.03 MANUFACTURED UNITS

A. General: Roof mounted units having electric heating elements and electric refrigeration.

B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, economizer exhaust fan, electric heating elements, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

C. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

D. Electrical Characteristics:
   1. As scheduled on the drawings and verified with available building voltage.

E. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26-27-17.

F. Service Receptacle: Furnish the unit with a non-powered service receptacle suitable for field wiring.

2.04 FABRICATION

A. Cabinet: Construction shall be a single, enclosed, weatherproof casing constructed of 20-gauge galvanized steel. Unit base is constructed of 16-gauge galvanized steel. Each exterior casing panel to be bonderized and finished with baked-on exterior polyester enamel paint prior to assembly. The baked-on cured paint finish shall pass the industry rub test with a minimum of 72 rubs MEK (Methyl, Ethyl Ketone) or standard rub test of a minimum of 100 rubs using Toluene, baked on paint, designed and tested to withstand 1000 hours of salt spray test per ASTM B117-03. Cooling section shall be fully insulated with a non-fiberglass material with heavy duty foil facing for durability and ease of cleaning. Fiberglass insulation is not acceptable. Openings shall be provided for power connections. Access openings appropriate for outside structure to all fan motors and compressor for making repairs and for removing internal components without removing unit from its permanent installation. Fresh air intake and outdoor coil shall be protected from intrusions by a sturdy metal grating with less than 1/4 inch openings.

B. Insulation: Insulation shall be non-fiberglass material with foil faced for ease of cleaning. Insulation materials used shall not contain fiberglass or formaldehyde.

C. Supply Fan: Forward curved centrifugal type, resiliently mounted with direct drive, high efficiency ECM variable speed motor. Isolated complete fan assembly.

D. Air Filters:
   1. 2 inch thick glass fiber disposable media in metal frames. Filters shall be Minimum Efficiency Reporting Value of MERV 8 per ASHRAE Standard 52.2. Filters shall be readily available commercial sizes.

E. Drain Pan: Drain pan shall be constructed with 20-gauge galvanized steel, bonderized and finished with baked-on exterior polyester enamel paint.

F. Mounting Brackets: Full-length, side mounting brackets shall be an integral part of the cabinet. Bottom mounting bracket shall be provided with unit.

2.06 EVAPORATOR COIL AND MOTOR

A. The evaporator coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes. Aluminum fins shall have hydrophilic coatings to aid in condensate drainage, inhibit mold growth and protect aluminum fins from oxidation.

B. Indoor Blower shall be 5-speed twin wheels with forward curve blades. Motor shall be high efficiency ECM with overload protection.

2.07 REFRIGERATION SYSTEM

A. Unit shall use a high efficiency hermetic scroll compressor. The compressor shall be covered by a 5-year parts warranty. The refrigeration circuit shall be equipped with factory installed high and low pressure controls, suction and liquid access valves, compressor control module and liquid line filter dryer. A

refrigerant metering device shall be included. Compressor shall be mounted on rubber grommets. Unit shall be provided with R-410A (HFC) non-ozone depleting refrigerant.

B. Five minute timed off circuit to delay compressor start.

C. Outdoor thermostat to energize compressor above 35 degrees F ambient.

D. Provide step capacity control by cycling compressors.

2.08 CONDENSER COIL

A. The condenser coil shall be constructed of aluminum plate fins mechanically bonded to seamless copper tubes.

B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors. The condenser fan, motor and shroud shall be of slide out configuration for easy access. Condenser fan motor shall be enclosed casing with ball bearings. Open winding motors are not acceptable.

2.09 VENTILATION CONFIGURATION

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting dampers with edge gaskets maximum leakage 5 percent at 2 inches pressure differential.

C. Damper Operator, Units 7.5 Ton Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.

2.10 OPERATING CONTROLS

A. The internal control circuit shall consist of a current limiting 24VAC type transformer with resettable circuit. The defrost circuit shall consist of a solid state electronic heat pump control. A 30-minute timer shall initiate a frost cycle if the outdoor coil temperature indicates the possibility of an iced condition. The thermistor sensor, speed-up terminal for service and a ten-minute defrost override shall be standard on the electronic heat pump control. To prevent rapid compressor short cycling, a five-minute time delay circuit shall be factory installed to prevent nuisance tripping during low temperature start-up. Provide terminal strip on unit for connection of operating controls under this contract. Control shall allow for three stages of heating and two stages cooling.

B. Electric solid state microcomputer based programmable room thermostat, located in service zone.

C. Low ambient control.

D. Outdoor air thermostat.

E. Filter differential pressure switch.

F. Economizer

1. The Economizer shall be internally mounted and allow outside air to be used for free-cooling when temperature and humidity conditions are favorable. The amount of exhaust air shall vary in response to the system controls and settings defined by the user. It shall include a built in exhaust air damper. The economizer is designed to provide free cooling when outside conditions are cool and dry enough to satisfy cooling requirements without operating the compressor, providing lower operating costs while extended the life of the compressor
2. Fully modulating.
3. 4 cfm/ft2 or less damper leakage rate at 1" w.c. pressurization.
4. Simple single blade design.
5. Positive shut-off with non–stick gaskets.
6. Electronic DB and Enthalpy sensors.
7. Honeywell JADE electronic economizer module with precision settings and diagnostics.
8. Honeywell hi-torque 44 lb.-in actuator.

2.11 HOT GAS REHEAT COIL FOR DEHUMIDIFICATION

A. Provide copper tube aluminum fin coil assembly arranged to provide reheat to the supply airstream downstream of the cooling coil.
   1. Provide modulating capacity control.
   2. The dehumidification circuit shall incorporate an independent heat exchanger coil in the supply air stream in addition to the standard evaporator coil. This coil shall reheat the supply air after it passes over the cooling coil and shall be sized to nominally match the sensible cooling capacity of the evaporator coil. Extended run times in dehumidification mode can be achieved using waste heat from the refrigeration cycle to achieve the reheat process, while at the same time, large amounts of moisture can be extracted from the passing air stream. Models that also have electric heaters installed shall have the electric heat inhibited during dehumidification mode, although it remains available for additional reheat during certain conditions. The dehumidification cycle shall be energized by a rise in relative humidity above set point. The unit shall energize in the cooling mode and also a two position valve will energize, allowing hot refrigerant gas to pass through the reheat coil, reheating the cold air leaving the evaporator coil. An electronic expansion valve (EEV) shall be utilized to help maintain a very low sensible capacity and consistent latent capacity. The dehumidification cycle shall have on/off capability. If the thermostat calls for cooling or heating during the dehumidification cycle, the unit shall drop out of dehumidification to satisfy the call from the thermostat.

2.12 HEATING

A. Heat Pump: The heat pump operation shall operate reversing valve in coordination with defrost and electric heat with standard heating capacities.

B. Electric Heat: Factory installed electric resistance heater designed specifically for application in the heat pump packages. Heater shall include automatic limit safety controls.

2.13 COOLING

A. STANDARD COOLING: The heat pump operation shall shall function with standard sensible and latent cooling capabilities with high speed airflow.

B. BALANCED CLIMATE COOLING: The heat pump shall function with enhanced latent capacity when BALANCED CLIMATE cooling mode is enabled. Unit shall include Y1 and Y2 low voltage terminal connections. A 2-stage thermostat shall be capable of operating BALANCED CLIMATE. Stage 1 cooling will operate with a preprogrammed and fully tested reduced fan speed. The reduction in fan speed increases latent capacity and reduces sensible capacity for increased runtime and increased latent capacity. If the 2 stage thermostat calls for second stage cooling, the unit shall shift to high speed blower and standard operation. BALANCED CLIMATE is achieved with a single stage compressor. Expanded rating in BALANCED CLIMATE mode shall be provided at time of submittal, and full factory performance data shall be available upon request

2.14 ELECTRICAL COMPONENTS

A. Electrical components shall be easily accessible for routine inspection and maintenance through front service panels. Circuit breaker is standard on all 208/230 volt models and toggle disconnect standard on all 460 volt models. Circuit breaker/toggle disconnect access shall be through lockable access panel.

2.15 CONTROL CIRCUIT

A. The internal control circuit shall include a current limiting 24VAC type transformer with resettable circuit. The defrost circuit shall include a solid state electronic heat pump control. A 30-minute timer shall initiate a frost cycle if the outdoor coil temperature indicates the possibility of an iced condition. The thermistor sensor, speed-up terminal for service and a ten-minute defrost override shall be standard on the electronic heat pump control. To prevent rapid compressor short cycling, a five-minute time delay circuit shall be factory installed to prevent nuisance tripping during low temperature start-up.

B. Phase rotation protection and phase failure protection shall be standard factory on all equipment with three-phase power. If unit is wired incorrectly, phase monitor will lock out compressor operation and red warning light shall energize. Once power wiring is corrected at field power wiring location, a green light will energize on phase monitor. If a phase of power is lost, the phase monitor will also lock out system operation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Coordinate dimensions required for framing to mount the unit to the framework. Ensure there is adequate blocking, studs, etc as required for securing unit to structure before exterior and interior finishes are applied.

D. Install unit to structure in accordance with manufacturer installation instructions and recommendations.

E. Install all flashing components, roof pan, etc and seal all gasps water tight with approved sealant.

F. Lift unit only at points specified by the manufacturer. Follow all manufacturer's instructions for rigging the unit for lifting.

G. Install supply and return duct sleeve connections in wall and install supply and return grilles to wall.

H. Coordinate with electrical contractor for power connections.

I. Install thermostat and make all low voltage connections with wiring in conduit.

3.03 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

A. Demonstrate operation to Owner's maintenance personnel.

B. Replace filters after final building clean-up just prior to Owner occupancy.

3.05 MAINTENANCE

A. Provide service and maintenance of packaged roof top units for one year from Date of Substantial Completion.

B. Provide routine maintenance service with a two month interval as maximum time period between calls.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

D. Provide 24-hour emergency service on breakdowns and malfunctions.

E. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION 23-74-13

SECTION 26-00-10

COMMON ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General project related items that apply to all Division 26 sections. The provisions included in this section are complementary to and amendatory of the Division 1 sections of these project specifications - they do not replace them.

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to this section. Where conflicts may exist between Division 1 Specifications Sections and Division 26 Specification Sections, the Division 1 provisions shall take precedence except for when the Division 26 provisions expand, enhance, or extend the project, material or equipment requirements.

1.03 REFERENCES

A. FM P7825 - Approval Guide; Factory Mutual.

B. NEMA MG 1 - Motors and Generators.

C. NFPA 70 - National Electrical Code.

D. SSPC-Paint 15 - Steel Joist Shop Paint; Steel Structures Painting Council.

E. North Carolina State Building Code (All Volumes)

1.04 DEFINITIONS

A. Building Code: Collectively, the current editions of all applicable codes whose requirements must be met in order for the Building Owner to be granted an Occupancy Permit by the authorities having jurisdiction over the building. These codes shall include but not be limited to the following specific volumes as well as any additional codes or standards referenced in these publications:
   1. General Construction.
   2. Administrative.
   3. Accessibility.
   4. Plumbing
   5. Mechanical.
   6. Electrical.
   7. Fire Prevention.
   7. Fuel Gas.
   8. Energy Conservation.

B. Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing work or offering to perform work. The term "Contractor" shall apply to such entity regardless of whether the entity is working as a Prime Contractor or as a Sub Contractor on the project.
   1. Prime Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing or offering to perform work and who is awarded a contract with the Owner for work on this project.
   2. Sub Contractor: A licensed individual, partnership, corporation or other business entity duly licensed in the State for the trade in which he is performing or offering to perform work and who is working on the project under contract with a Prime Contractor.

C. Building Related Laws: Collectively, the current editions of all applicable laws whose requirements must be met in order for the Building Owner to provide access to the public and to occupy and conduct business lawfully including any additional laws, codes or standards referenced in these laws. These laws include but are not limited to the following:
   1. Americans With Disabilities Act.
   2. Energy Policy Act.

D. Provide: When used in these specifications or on the drawings, the term "provide" shall mean to furnish, install, and adjust as required for safe and efficient operation.

E. Supply: When used in these specifications or on the drawings, the term "supply" shall mean to furnish with all required appurtenances for a complete installation and advise the installing contractor on details relating to the installation as needed.

1.05 GENERAL PROJECT REQUIREMENTS

A. The plans and specifications for this project are prepared to represent the general project requirements and intent. They are diagrammatic in nature and are not intended to show each and every fitting, offset, or other modifications or minor devices that may be required in the field to provide a complete system that is safe, efficient and effective in operation. Minor components or modifications that are required to provide a safe, efficient and effective system shall be included in the bid price whether or not they are specifically called for on the plans or in these specifications. It is understood that the contractors bidding this project are required to be licensed in their respective trade and are therefore knowledgeable in the trade in which they are licensed.

B. The Contractor shall provide all contingencies and supply all tools, fixtures, transportation, etc. as well as materials necessary for installation. In all its details, the work and materials shall be subject to the approval of the Architect or Engineer whose decision on all points of difference shall be final and binding on this Contractor.

C. The Contractor shall secure and pay for all necessary approvals, permits, inspections, certificates etc.. required by state or local codes or statutes, rules, or regulations and pay all fees required unless specifically noted otherwise. The Contractor shall notify the local Electrical Inspector and schedule required inspections.

D. All work and materials are required to be in compliance with State and Local Codes. Any conflicts between the plans and State or Local Codes, Rules, Statutes, or Regulations shall be brought to the Architect's or Engineer's attention in writing immediately.

E. Plans are diagrammatic in nature and show the general design and arrangement of the systems. They are not intended to show each and every offset or fitting required for installation of work under this contract. This Contractor, as a licensed professional, is required to be proficient and knowledgeable in his trade and is required to include all such items and contingencies in his bid. The plans are not to be scaled for rough-in dimensions nor are they to be used for shop drawings.
   1. Where dimensions are given on the plans, they must be verified with actual field measurements taken on the project site. This Contractor shall take such field measurements as required to coordinate the installation of his work or to prepare shop drawings.
   2. Slight relocation of fixtures, equipment, devices and other items may be made by this Contractor as required to fit his work to casework, trim, brick coursing, etc. as long as such relocation does not interfere with work of any other Contractor.

1.06 SYSTEM DESCRIPTION

A. Provide limited electrical demolition, disconnection, reconnection, and new circuits for new equipment as required.
   1. Disconnect power wiring from all existing equipment that is to be removed, demolished or salvaged.
   2. Remove and temporarily support the following items from existing ceilings that are to be removed for access to piping and equipment above the ceilings:
      a. Light fixtures: Remove attachments to ceiling grid and support fixtures from existing structure 2" above the elevation of the ceiling. Re-attach to new ceiling grid when installed.
      b. Speakers: Detach from existing ceiling. Temporarily support above the ceiling elevation until the new ceiling is installed - then reinstall in new ceiling.
      c. Smoke Detectors: Detach from existing ceilings. Provide dust cover for each detector and support 2" above ceiling elevation. Reinstall in new ceilings, then remove covers after building cleanup is completed.

d. Wireless access points: Detach from existing ceilings. Provide dust cover for each unit and support 2" above ceiling elevation. Reinstall in new ceilings, then remove covers after building cleanup is completed.
e. Cameras: Detach from existing ceilings. Provide dust cover for each camera and support 2" above ceiling elevation. Reinstall in new ceilings, then remove covers after building cleanup is completed.
f. Motion Detectors: Detach from existing ceilings. Provide dust cover for each detector and support 2" above ceiling elevation. Reinstall in new ceilings.

3. Remove existing duct smoke detectors from existing ducts that are removed. Provide bag cover for sample tubes and detector housing. Temporarily support detectors to minimize exposure to damage from new duct and equipment installation. Reinstall detectors in ductwork after duct and equipment installation is completed.
4. Remove existing starters for pumps, air handling units, fans, etc. that re removed. Connect to new starter or VFD for new equipment and wire from starter/VFD and connect to the new equipment.
5. Connect existing power wiring to replacement equipment installed under this contract.
6. Provide new circuits for new equipment installed under this contract.

1.07 COORDINATION OTHER DIVISIONS (AND COORDINATION DRAWINGS)

A. Requirements noted in this division are intended to be supplementary to Division 1 requirements. Where Division 1 requirements exceed the requirements in this section, the Division 1 requirements shall govern. Where requirements in this section exceed Division 1 requirements, the requirements in this division shall govern. This Contractor is required to review the Division 1 requirements as well as other Divisions to allow coordination of his work with other trades.

B. Coordinate with other contractors (Division 22 and Division 23 contractors other equipment installers) to locate point of electrical connection for each piece of equipment and to identify location for point of demarcation from Division 26 contractor wiring. Note that connections to monitoring or switching related devices such as flow and tamper switches, contactors, etc. are to be made under this contract.

1.08 PERFORMANCE REQUIREMENTS

A. All equipment installed in fire rated walls, ceilings, or other partitions shall be listed to maintain the fire rating and shall be installed to maintain the rating.

B. Materials (such as conduit) passing through fire rated walls, ceilings or other partitions shall be suitably firestopped using only approved materials and methods to maintain the fire rating of the assembly.

C. Schedule all required inspections by State and Local Authorities, and make all corrections as required by such inspections.

1.09 SUBMITTALS

A. Submit Coordination Drawings in accordance with Division 1 requirements.

B. Shop Drawings: Submit shop drawings as specified in the respective specification section. When equipment, materials or systems other than the one specified are submitted, this Contractor shall be required to clearly mark differences between the items submitted and the items specified. This Contractor shall be responsible for all changes required (including but not limited to piping, wiring, mounting, clearances, etc.) under this and other divisions due to the use of items other than those specified.
1. Submit shop drawings in one complete package and not at intervals.
2. The Contractor shall check each submittal for accuracy and completeness prior to submitting the shop drawings to the Engineer. The Contractor shall stamp and sign the documents accordingly
3. Each item being submitted for review shall be clearly identified in the submittal. In the event that multiple items are cataloged in a section and a single item is not clearly identified as the one that is being submitted, the Engineer may at his discretion select any suitable item from the page that meets or exceeds the requirements for the project.

C. Test Reports: Indicate results of all testing.

D. Operation and Maintenance Manuals: Submit quantities as required in Division 1 sections (but not less than 3 sets) bound and tabbed in three ring binders with the project name, the contractors name and

contact information and relevant installation, operating and maintenance data for all equipment installed on the project.

1.10 QUALITY ASSURANCE

A. Perform in accordance with state and local building codes, laws and ordinances.

B. Obtain and pay for all inspections, permits, and fees required for work under this contract.

C. Substitutions: Substitutions shall be made in accordance with the procedures given in the applicable Division 1 sections. The following procedures shall supplement the procedures given in Division 1. In the event that there are not substitution procedures given in Division 1, these procedures shall be used for all Division 22, 25 and 26 items.

1. When equipment, materials or systems other than the one specified are submitted, this Contractor shall be required to clearly mark differences between the items submitted and the items specified. This Contractor shall be responsible for all changes required (including but not limited to piping, wiring, mounting, clearances, etc.) under this and other divisions due to the use of items other than those specified. The costs for these required changes shall be borne by the Contractor making the substitution at no additional costs to the Owner. The Engineer's decision on the acceptability of substitute equipment shall be final and binding under this contract. The acceptance of substitute items shall in no way relieve the Contractor from meeting any of the project requirements.
2. Items that are to be substituted for a specified item shall be equal in quality, performance, capacity, size, construction, utility requirements, appearance, etc. to the item specified.
3. Substitutions may be made for all items specified using the term "or equal". Where an item is specified without the use of the term "or equal" that item must be used for the project bid. No substitutions may be made for items that are specified without the "or equal" term.
4. Items exceeding the performance, efficiency, quality, etc. may be used when approved by the Engineer, but no additional money will be paid under the contract for such features.
5. The Engineer may consider qualities and characteristics of the specified item which may or may not have been specifically called out in the schedules or specifications when evaluating the suitability of a substitute item. The Engineer's decision regarding the acceptability of substitute items shall be final and binding under this contract.

D. Provide testing of the following components of the electrical system. Document each test to indicate the time of day, the date, temperature, person performing the tests and all pertinent test information to the particular test. Submit documentation of each of the tests prior to and as one of the prerequisites for final acceptance of the project.

1. Ground System Testing: Upon completion of the electrical grounding and bonding systems, the ground resistance shall be tested with a ground resistance tester. Take corrective action to reduce the resistance to ground to a value of 25 ohms or less as part of work included under this contract (including driving additional ground rods if required). Retest and implement corrective measures as required until the resistance to ground is 25 ohms or less.
2. Feeder Insulation Resistance Testing: Test with a 500 volt megger.
    a. Test all current carrying phase conductors and neutrals after installation in raceways and before connections to gear or other equipment are made. Minimum values shall be 1,000,000 ohms for #6 AWG and smaller; 250,000 ohms for #4 and larger conductors measured between conductors and between the conductors and grounding conductor.
    b. After all fixtures, devices and equipment are installed and all connections completed to each panel, disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, disconnect the branch circuit neutral wires from the neutral bar, then test each one separately until the low reading conductors are found. Correct the indicated troubles, reconnect and re-test until each conductor measures at least 250,000 ohms from the neutral bar to the grounded panel enclosure with the neutral feeder disconnected.
    c. At final inspection, furnish a megger and demonstrate to the Engineer and State Construction Office representatives that the panels comply with the above requirements. Also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.

3. Circuit Breaker Tests: Perform the following tests for services 1000 amperes and larger. Tests shall be performed on the service circuit breakers and the distribution circuit breakers. Testing shall be performed by a qualified factory technician at the jobsite. All readings shall be clearly tabulated and documented.
    a. Phase Tripping Tolerance - Demonstrate tolerances (amps) are within 20% per UL requirements)
    b. Trip Time (per phase) - in seconds.
    c. Instantaneous Trips (amps) per phase.
    d. Insulation Resistance (in megaohms) at 100 volts (phase to phase and line to load).
4. Ground Fault Protection System
    a. Performance Testing for proper operation and properly calibrated and set for the project conditions.

E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience and properly licensed to perform the work.

1.11 DELIVERY, STORAGE, AND PROTECTION

A. Store materials and equipment under cover and elevated above grade until ready for installation.

B. Deliver materials and products to project site in their original shipping containers.

1.12 PROJECT CONDITIONS

A. Coordinate equipment installation with size, location and installation of service utilities.

B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.13 WARRANTY

A. See Division 1 Sections for additional warranty requirements.

B. All labor, materials, and products supplied on this project shall have a minimum of 1 year parts and labor replacement warranty.

C. Consult individual specification sections for additional warranty requirements. Warranty requirements stated in the subsequent specifications sections are supplemental to requirements in this warranty section.

D. Correct defective Work within a on- year period after Date of Final Acceptance unless a different date is given in Division 1 specifications sections. Provide all materials, labor, supplies etc. as required to remove, disassemble, replace, reassemble, etc. failed or otherwise defective parts that are covered under the warranty terms.

PART 2 PRODUCTS

2.01 MATERIALS AND PRODUCTS

A. All materials and products shall be new and shall comply with the requirements of the North Carolina State Building Code and the NFPA 70 (National Electrical Code) with North Carolina Amendments.

B. All materials and products shall be UL or other acceptable listing agency listed where such listing is available for the material used. Where a listing is not available, materials shall be appropriately selected for their intended use.

C. All materials and products shall be the appropriate type for the installed location.

D. Hazardous (Classified) locations: In accordance with the appropriate section of Article 500 of NFPA 70.

E. Where not specifically noted otherwise on the plans, enclosures for electrical equipment shall be as follows:
    1. Indoors, in clean environments: NEMA 1 rated.
    2. Outdoors, or otherwise exposed to the weather or moisture: NEMA 3R rated.
    3. Hazardous (Classified) locations: In accordance with the appropriate section of Article 500 of NFPA 70.

F. Lighting fixtures shall be supplied complete with lamps, ballasts, lenses (unless the fixture specified is an open type fixture), thermal protection, trim appropriate for the surface that the fixture is mounted on or in and supports as required to support the fixture from the building structure - independent of the ceiling grid.

G. Control devices (starters) shall be supplied complete with thermal overload elements, Hand-Off-Auto switches, control coils of the appropriate coil voltage for the application, enclosure, fuses (when the starter is part of a combination starter/disconnect unit), and indicating lights indicating when the load is energized.

H. Non-fusible disconnect switches shall be furnished complete with operator handles, enclosures, sized for the load or the nameplate data of the equipment supplied,

I. Fusible disconnect switches shall be furnished complete with operator handles, enclosures, fuses sized for the load or the nameplate data of the equipment supplied,

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that the building and site conditions are in the proper stage of construction for the installation of electrical materials and equipment prior to installing such equipment. Do not install electrical equipment when it would be subject to damage from the elements or vandalism due to an unsecured building.

B. Verify that proper installation and service clearance is available in the intended location of electrical equipment prior to installing equipment.

C. Schedule all required inspections by State and Local Authorities, and make all corrections as required by such inspections.

3.02 INSTALLATION

A. Install all equipment and materials in accordance with manufacturer's instructions, the UL listing, and all State and Local codes and Ordinances.

B. Coordinate rough-in of convenience outlets, light switches, fire alarm devices, etc. with the requirements of the Americans With Disabilities Act requirements.

C. Identify all panelboards, disconnect switches, starters, etc. with labels screw or rivet attached to the enclosure.

D.

3.03 INTERFACE WITH OTHER WORK

A. This Contractor shall coordinate his work with that of all other Contractors on the project and shall consult the drawings and specifications of the other trades to determine the nature and effect of work by others. This Contractor shall be responsible for all his work fitting in place with in an approved manner, and shall consult with others as required for drawings, dimensions, elevations, actual building measurements, etc. as necessary to ensure that his work does fit properly and does not conflict with other trades.

B. In the event that interferences develop, this Contractor shall cooperate with others to eliminate the interference. Should pipes, ductwork, conduit, equipment or other items have to be relocated, the Architect's or Engineer's decision will be the final authority as to which Contractor shall relocate his work.

C. Consult with other contractors for equipment electrical requirements and to determine exact rough-in and connection locations. Instruct these contractors on materials and methods required to comply with Division 26 requirements when making final electrical connections to the equipment.

D. Coordinate actual devices to be supplied for connection to equipment installed by other Contractors, Subcontractors or Owner on the project.

E. Coordinate voltage and current characteristics of all equipment installed by other Contractors, Subcontractors or Owner on the project. Coordinate with the actual equipment that is installed.

F. Make power connections to all equipment installed by other Contractors, Subcontractors or Owner on the project.

G. Provide additional intermediate steel members and attach the steel to the building structure as required to provide structurally sound point of attachment for conduit, lighting fixture and equipment supports. Install intermediate steel at approved panel points on bar joists. Do not attach to cross bracing that is attached to bar joists. Attach to bar joists at panel points only. Do not attach to bar joists at any point or

in any manner that is not approved by the bar joist manufacturer. Paint all bare steel surfaces of supporting steel to prevent rust. Relocate all attachments that are found to be made in unapproved locations.

3.04 STARTING EQUIPMENT AND SYSTEMS

A. Provide manufacturer's field representative to prepare and start equipment and systems where so specified. Where not specified, start equipment and systems in accordance with the manufacturer's instructions and recommendations. Provide all test instruments, power, personnel and materials as required to start the equipment and systems.

B. Adjust for proper operation within manufacturer's published tolerances.

C. Demonstrate proper operation of equipment to Owner 's designated representative.

3.05 ADJUSTING

A. Adjust equipment and systems for safe and efficient operation.

3.06 CLEANING

A. Clean all equipment prior to substantial completion.

B. Protect installed equipment and materials from subsequent construction operations.

C. Do not permit traffic over unprotected floor surface.

END OF SECTION 26-00-10

SECTION 26-05-05

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

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

PART 3 EXECUTION

3.01 EXAMINATION

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

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

C. Report discrepancies to Engineer before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

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

B. Coordinate any utility service outages with utility company and with Owner.

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

D. Existing Electrical Service: Maintain existing system in service while additions and modifications to the existing system are being made. Energize new gear, circuits, etc. only after they are fully installed and ready for service. Disable system only as required to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

F. Existing Fire Alarm System: Maintain existing system in service until new portions of the system are accepted. Do not disable system unless necessary for reprogramming or connection of new circuits.
   1. Notify Owner before partially or completely disabling system.
   2. Notify local fire service.
   3. Make notifications at least 48 hours in advance.
   4. Make temporary connections to maintain service in areas adjacent to work area.

G. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner at least 48 hours before partially or completely disabling system.
   2. Notify telephone utility company at least 24 hours before partially or completely disabling system.
   3. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

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

B. Remove abandoned wiring to source of supply.

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

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

E. Disconnect and remove abandoned panelboards and distribution equipment.

F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

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

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

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

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

3.04 CLEANING AND REPAIR

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

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

C. Provide typed directories as required for all existing panelboards. New directories will be required to conform with revised room numbers even though no work may have been performed in these areas.

END OF SECTION 26-05-05

SECTION 26-05-19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Manufactured wiring systems.

C. Wiring connectors.

D. Electrical tape.

E. Heat shrink tubing.

F. Wire pulling lubricant.

G. Cable ties.

1.02 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.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.

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

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.

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

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction.

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

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

J. NFPA 70 - National Electrical Code.

K. UL 44 - Thermoset-Insulated Wires and Cables.

L. UL 83 - Thermoplastic-Insulated Wires and Cables.

M. UL 183 - Manufactured Wiring Systems.

N. UL 486A-486B - Wire Connectors.

O. UL 486C - Splicing Wire Connectors.

P. UL 486D - Sealed Wire Connector Systems.

Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.04 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 of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. 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.

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

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten 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.

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 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 Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

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

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

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.

F. Armored cable is not permitted.

G. Metal-clad cable is not permitted.

H. Manufactured wiring systems are permitted only as follows:
1. Where not otherwise restricted, may be used:
   a. For branch circuits where concealed under raised floors, where concealed above accessible ceilings for lighting, and in open ceiling areas for lighting.
      1) Exception: Provide single conductor building wire in raceway for circuit homerun from distribution box to panelboard.
2. In addition to other applicable restrictions, may not be used:
   a. Where exposed to damage.
   b. For damp, wet, or corrosive locations.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

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

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

C. 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/B787M 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.
         3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.

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.
      a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. 240/120 V High-Leg Delta, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B (High-Leg): Orange.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      d. 240/120 V, 1 Phase, 3 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Neutral/Grounded: White.
      e. Equipment Ground, All Systems: Green.
      f. Isolated Ground, All Systems: Green with yellow stripe.
      g. Travelers for 3-Way and 4-Way Switching: Pink.
      h. 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.

i. For control circuits, comply with manufacturer's recommended color code.

2.03 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.

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. Installed Underground: Type XHHW-2.
b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 MANUFACTURED WIRING SYSTEMS

A. Manufacturers:
1. AFC Cable Systems Inc: www.afcweb.com.
2. RELOC Wiring Solutions, a brand of Acuity Brands, Inc: www.relocwiring.com.
3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us.

B. Description: Manufactured wiring assemblies complying with NFPA 70 Article 604, and listed and labeled as complying with UL 183.

C. Provide components necessary to transition between manufactured wiring system and other wiring methods.

D. Branch Circuit Cables:
1. Conductor Stranding (Size 10 AWG and Smaller): Solid.
2. Insulation Voltage Rating: 600 V.
3. Insulation: Type THHN.
4. Provide dedicated neutral conductor for each phase conductor where indicated or required.
5. Grounding: Full-size integral equipment grounding conductor.
6. Armor: Steel, interlocked tape.

E. Connectors: Keyed and color-coded to prevent interconnection of different voltages.

F. Fixture Leads: Type TFN insulation.

2.05 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.

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. NSI Industries LLC: www.nsiindustries.com.

H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
a. Burndy: www.burndy.com.
b. Ilsco: www.ilsco.com.
c. Thomas & Betts Corporation: www.tnb.com.

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.

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.

2.06 WIRING ACCESSORIES

A. Electrical Tape:
1. Manufacturers:
a. 3M: www.3m.com.
b. Plymouth Rubber Europa: www.plymouthrubber.com.
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. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
7. 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.

C. 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. American Polywater Corporation: www.polywater.com.
c. Ideal Industries, Inc: www.idealindustries.com.

D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

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

D. Verify that field measurements are as indicated.

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

3.02 INSTALLATION

A. Circuiting Requirements:
1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. Arrange circuiting to minimize splices.
3. Include circuit lengths required to install connected devices within 10 ft of location indicated.
4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
a. Increase size of conductors as required to account for ampacity derating.
b. Size raceways, boxes, etc. to accommodate conductors.
7. 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.
8. Provide oversized neutral/grounded conductors where indicated and as specified below.
a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
b. 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. Perform work in accordance with NECA 1 (general workmanship).

D. 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.

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

F. 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.

G. Install conductors with a minimum of 12 inches of slack at each outlet.

H. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

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

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

K. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

L. 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 un-spliced 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.
    b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical 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.

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

N. 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.

O. Identify conductors and cables in accordance with Section 26-05-53.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07-84-00.

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

3.03 FIELD QUALITY CONTROL

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

B. 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.

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

END OF SECTION 26-05-19

SECTION 26-05-26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Chemically-enhanced ground electrodes.

G. Ground plate electrodes.

H. Ground enhancement material.

I. Ground access wells.

1.02 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.

1.03 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code.

F. UL 467 - Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

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

B. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 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.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

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

C. 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.

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

E. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

F. 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 Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal In-Ground Support Structure:
      a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
   4. Concrete-Encased Electrode:
      a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
   5. Ground Rod Electrode(s):
      a. Provide two electrodes unless otherwise indicated or required.
      b. Space electrodes not less than 10 feet from each other and any other ground electrode.
      c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
      d. Provide ground enhancement material around electrode if required.
      e. Provide ground access well for each electrode.

6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. 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.
    b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
    c. Ground Bar Mounting Height: 48 above finished floor unless otherwise indicated.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
    a. Transformers (except autotransformers such as buck-boost transformers).
    b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
    c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. 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.
8. Provide bonding for metal building frame.
9. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.

2.02 GROUNDING AND BONDING COMPONENTS

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

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26-05-26:
1. Use insulated copper conductors unless otherwise indicated.
    a. Exceptions:
        1) Use bare copper conductors where installed underground in direct contact with earth.
        2) Use bare copper conductors where directly encased in concrete (not in raceway).
2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gage of specified conductors.

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.
    a. Exceptions:
        1) Use exothermic welded connections for connections to metal building frame.
4. Manufacturers - Mechanical and Compression Connectors:
    a. Advanced Lightning Technology (ALT): www.altfab.com.
    b. Burndy: www.burndy.com.
    c. Harger Lightning & Grounding: www.harger.com.
    d. Thomas & Betts Corporation: www.tnb.com.

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. Advanced Lightning Technology (ALT): www.altfab.com.
    b. Erico International Corporation: www.erico.com.
    c. Harger Lightning & Grounding: www.harger.com.
    d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.

3. Size: 3/4 inch diameter by 8 feet length, unless otherwise indicated.
4. Manufacturers:
    a. Advanced Lightning Technology (ALT): www.altfab.com.
    b. Erico International Corporation: www.erico.com.
    c. Galvan Industries, Inc: www.galvanelectrical.com.

F. Chemically-Enhanced Ground Electrodes:
1. Description: Copper tube factory-filled with electrolytic salts designed to provide a low-impedance ground in locations with high soil resistivity; straight (for vertical installations) or L-shaped (for horizontal installations) as indicated or as required.
2. Length: 10 feet.
3. Integral Pigtail: Factory-attached, sized not less than grounding electrode conductor to be attached.
4. Backfill Material: Grounding enhancement material recommended by electrode manufacturer.
5. Manufacturers:
    a. Advanced Lightning Technology (ALT): www.altfab.com.
    b. Erico International Corporation: www.erico.com.
    c. Harger Lightning & Grounding: www.harger.com.
    d. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.

G. Ground Plate Electrodes:
1. Material: Copper.
2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
3. Manufacturers:
    a. Advanced Lightning Technology (ALT): www.altfab.com.
    b. Erico International Corporation: www.erico.com.
    c. Harger Lightning & Grounding: www.harger.com.
    d. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.

H. Ground Enhancement Material:
1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
2. Resistivity: Not more than 20 ohm-cm in final installed form.
3. Manufacturers:
    a. Erico International Corporation: www.erico.com.
    b. Harger Lightning & Grounding: www.harger.com.
    c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.

I. Ground Access Wells:
1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
    a. Round Wells: Not less than 8 inches in diameter.
    b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
    a. Advanced Lightning Technology (ALT): www.altfab.com.
    b. Erico International Corporation: www.erico.com.
    c. Harger Lightning & Grounding: www.harger.com.
    d. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

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

3.02 INSTALLATION

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

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

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.

E. 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.

F. Identify grounding and bonding system components in accordance with Section 26-05-53.

3.03 FIELD QUALITY CONTROL

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

B. Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 26-05-26

SECTION 26-05-29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 03-30-00 - Cast-in-Place Concrete: Concrete equipment pads.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

D. MFMA-4 - Metal Framing Standards Publication.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction.

F. NFPA 70 - National Electrical Code.

1.04 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 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.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

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

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 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 with a minimum safety factor of 2. 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. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. 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 Electric Co: www.emerson.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 Electric Co: www.emerson.com.

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 Material:
      a. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
   4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
   5. 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.

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 (27 mm) trade size: 1/4 inch diameter.
      d. Single Conduit larger than 1 inch (27 mm) 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. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
4. Manufacturers:
a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
b. Erico International Corporation: www.erico.com.
c. PHP Systems/Design: www.phpsd.com.
d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.

G. 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 or machine bolts.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Powder-actuated fasteners are permitted only as follows:
a. Where other methods of attachment will not produce satisfactory results and powder actuated fasteners can be safely driven without damaging the substrate material.
10. 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. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
11. Manufacturers - Mechanical Anchors:
a. Hilti, Inc: www.us.hilti.com.
b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
c. Powers Fasteners, Inc: www.powers.com.
d. Simpson Strong-Tie Company Inc: www.strongtie.com.
12. Manufacturers - Powder-Actuated Fastening Systems:
a. Hilti, Inc: www.us.hilti.com.
b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com.
c. Powers Fasteners, Inc: www.powers.com.
d. Simpson Strong-Tie Company Inc: www.strongtie.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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.

3.02 INSTALLATION

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

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

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. 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.

H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

K. 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.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

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

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26-05-29

SECTION 26-05-33.13

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Intermediate metal conduit (IMC).

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

D. Flexible metal conduit (FMC).

E. Liquidtight flexible metal conduit (LFMC).

F. Electrical metallic tubing (EMT).

G. Rigid polyvinyl chloride (PVC) conduit.

H. Reinforced thermosetting resin conduit (RTRC).

I. Conduit fittings.

J. Accessories.

K. Conduit, fittings and conduit bodies.

1.02 RELATED REQUIREMENTS

A. Section 26-05-26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

B. Section 26-05-29 - Hangers and Supports for Electrical Systems.

C. Section 26-05-53 - Identification for Electrical Systems.

D. Section 26-05-33.16 - Boxes for Electrical Systems.

E. Section 26-05-53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

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

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

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC).

D. NECA 1 - Standard for Good Workmanship in Electrical Construction.

E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).

F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).

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

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

I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.

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

K. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series.

L. NFPA 70 - National Electrical Code.

M. UL 1 - Flexible Metal Conduit.

N. UL 6 - Electrical Rigid Metal Conduit-Steel.

O. UL 360 - Liquid-Tight Flexible Steel Conduit.

P. UL 514B - Conduit, Tubing, and Cable Fittings.

Q. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

R. UL 797 - Electrical Metallic Tubing-Steel.

S. UL 1242 - Electrical Intermediate Metal Conduit-Steel.

1.04 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 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.

1.05 SUBMITTALS

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

B. 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.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 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, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
5. 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.
6. 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. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

E. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

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

I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

J. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

L. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit.

M. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), aluminum rigid metal conduit, or PVC-coated galvanized steel rigid metal conduit.

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet.

O. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquid-tight flexible metal conduit.
   3. Maximum Length: 6 feet unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.
      c. HVAC Equipment and motorized Plumbing Equipment.

P. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Fittings for Grounding and Bonding: Also comply with Section 26-05-26.

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

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

E. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 1/2 inch (16 mm) trade size.
   2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
   3. Control Circuits: 1/2 inch (16 mm) trade size.
   4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
   5. Underground, Interior: 3/4 inch (21 mm) trade size.
   6. Underground, Exterior: 1 inch (27 mm) trade size.

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

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
   1. Allied Tube & Conduit: www.alliedeg.com.
   2. Republic Conduit: www.republic-conduit.com.
   3. Wheatland Tube Company: www.wheatland.com.

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 Electric Co: www.emerson.com.
      c. Thomas & Betts Corporation: www.tnb.com.
   2. Non-Hazardous Locations: Use 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. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
   1. Allied Tube & Conduit: www.alliedeg.com.
   2. Republic Conduit: www.republic-conduit.com.
   3. Wheatland Tube Company: www.wheatland.com.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
   1. Manufacturers:
      a. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
      c. Thomas & Betts Corporation: www.tnb.com.
   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.
   5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

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

A. Manufacturers:
   1. Allied Tube & Conduit.
   2. Thomas & Betts Corporation: www.tnb.com.
   3. Robroy Industries: www.robroy.com.

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. Interior Coating: Urethane, minimum thickness of 2 mil.

E. 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.

F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

G. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.06 FLEXIBLE METAL CONDUIT (FMC)

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

B. Fittings:
   1. Manufacturers:
      a. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
      c. Thomas & Betts Corporation: www.tnb.com.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.

2.07 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.

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 Electric Co: www.emerson.com.
      c. Thomas & Betts Corporation: www.tnb.com.
   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.
      b. Do not use potted metal or indenter type fittings.

2.08 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Allied Tube & Conduit: www.alliedeg.com.
   2. Republic Conduit: www.republic-conduit.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. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
      c. Thomas & Betts Corporation: www.tnb.com.
   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. Connectors and Couplings: Use compression (gland) or set-screw type.
      a. Do not use indenter type connectors and couplings.
      b. Do not use potted metal or set-screw type connectors or couplings.
   5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

D.

2.09 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. AFC Cable Systems, Inc.
   5. Electri-Flex Company.

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.

D. Fittings and Conduit Bodies: NEMA TC 3.

2.10 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).

B. Supports: Per manufacturer's recommendations.

C. Fittings: Same type and manufacturer as conduit to be connected.

2.11 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. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

E. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

F. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

G. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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

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

D. Verify routing and termination locations of conduit prior to rough-in.

E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

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

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

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

G. Install nonmetallic conduit in accordance with manufacturer's instructions.

H. Arrange supports to prevent misalignment during wiring installation.

I. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

J. Provide additional intermediate steel members and attach the steel to the building structure as required to provide structurally sound point of attachment for conduit supports. Install intermediate steel at approved panel points on bar joists. Do not attach to bar joists at any point or in any manner that is not approved by the bar joist manufacturer. Relocate all attachments that are found to be made in unapproved locations.

K. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

L. Fasten conduit supports to building structure and surfaces under provisions of Section 26-05-29.

M. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

N. Do not attach conduit to ceiling support wires.

O. Arrange conduit to maintain headroom and present neat appearance.

P. Route all above slab conduit parallel and perpendicular to walls.

Q. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

R. Route conduit under slab from point-to-point where feasible.

S. Maintain adequate clearance between conduit and piping.

T. Cut conduit square using saw or pipe cutter; de-burr cut ends.

U. Bring conduit to shoulder of fittings; fasten securely.

V. 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.

W. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

X. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch size.

Y. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

Z. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.

AA. Provide suitable pull string in each empty conduit except sleeves and nipples.

AB. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

AC. Install expansion fittings every 200 linear feet and wherever structural expansion joints are crossed.

AD. Ground and bond conduit under provisions of Section 26-05-26.

AE. Identify conduit under provisions of Section 26-05-53.

AF. Couplings and terminations for EMT conduit shall be made utilizing plated steel hexagonal compression connectors. No pot metal, setscrew or indented type fittings shall be used.

AG. Conduit Routing:
1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
    a. Electrical rooms.
    b. Mechanical equipment rooms.
    c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
    a. Across floors.
    b. Across roofs.
    c. Across top of parapet walls.
    d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 2" from steel or wood roof decking.
14. 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.

AH. 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. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.

5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
9. Use of spring steel conduit clips for support of conduits is permitted only as follows:
10. Use of wire for support of conduits is permitted only as follows:
    a. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).
11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

AI. 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.

AJ. 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. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. 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.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07-84-00.

AK. Underground Installation:
1. Provide trenching and backfilling as required for installing underground conduits. Boring may be acceptable but only upon written approval by the owner or engineer.
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 all PVC conduits.

AL. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03-30-00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

AM. 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 calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
4. Where conduits are subject to earth movement by settlement or frost.

AN. 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.
3. Where conduits penetrate coolers or freezers.

AO. 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.

AP. Provide grounding and bonding in accordance with Section 26-05-26.

AQ. Identify conduits in accordance with Section 26-05-53.

3.03 FIELD QUALITY CONTROL

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

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

C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

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

3.05 PROTECTION

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

3.06 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in the UL firestopping method instructions.

B. Provide all openings and sleeves for conduits penetrating exterior walls, interior walls and other partitions, floors and roofs. Waterproof penetrations through exterior walls. Seal all other penetrations smoke-tight..

C. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified in Roofing Section of Division 7.

D. Provide conduit fittings to penetrate cabinets of equipment. Do not route conduits through factory cut or field cut holes in cabinets.

END OF SECTION 26-05-33.13

SECTION 26-05-33.16

BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 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.

1.02 RELATED REQUIREMENTS

A. Section 08-31-00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

B. Section 26-05-29 - Hangers and Supports for Electrical Systems.

C. Section 26-05-33.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

D. Section 26-27-26 - Wiring Devices:
   1. Wall plates.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

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

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. NFPA 70 - National Electrical Code.

G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

I. UL 508A - Industrial Control Panels.

J. UL 514A - Metallic Outlet Boxes.

1.04 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 of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. 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.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 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. 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.
11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
12. Wall Plates: Comply with Section 26-27-26.

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:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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

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

3.02 INSTALLATION

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

B. Install boxes in accordance with NECA 1 (general workmanship) 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. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

G. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Section 08-31-00 as required.
   2. Unless dimensioned, box locations indicated are approximate.
   3. Locate boxes as required for devices installed under other sections or by others.
   4. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26-05-33.13.
   5. Locate junction and pull boxes in the following areas, unless otherwise indicated:
      a. Concealed above accessible suspended ceilings.
      b. Within joists in areas with no ceiling.
      c. Electrical rooms.
      d. Mechanical equipment rooms.

H. 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.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
   4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

I. Install boxes plumb and level.

J. 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.

K. Install boxes as required to preserve insulation integrity.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements, using

materials and methods specified in Section 07-84-00.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide grounding and bonding in accordance with Section 26-05-26.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26-05-53

SECTION 26-05-53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Building wire color coding.

E. Voltage markers.

F. Underground warning tape.

G. Warning signs and labels.

H. Field-painted identification of conduit.

1.02 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.

C. NFPA 70 - National Electrical Code.

D. NFPA 70E - Standard for Electrical Safety in the Workplace.

E. UL 969 - Marking and Labeling Systems.

1.03 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.

1.04 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. 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. Switchboards:

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.

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.
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. Transformers:
1) Identify kVA rating.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

f. 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.

g. Time Switches:
1) Identify load(s) served and associated circuits controlled. Include location.

h. Enclosed Contactors:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
4) Identify coil voltage.
5) Identify load(s) and associated circuits controlled. Include location.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.
b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
c. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.

3. Emergency System Equipment:
    a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
    b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
    c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
6. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
7. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.
8. Use identification label on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
9. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
10. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
    a. Service equipment.
    b. Industrial control panels.
    c. Motor control centers.
    d. Elevator control panels.
    e. Industrial machinery.
11. 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.
12. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
13. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
14. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
15. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

C. 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.
    d. In cable tray, at maximum intervals of 20 feet.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

D. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
    a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
        1) Color Code:
            (a) Emergency Power System: Red.
            (b) Fire Alarm System: Red.
        2) Field-Painting: Comply with Section 09-91-23 and 09-91-13.
        3) Vinyl Color Coding Electrical Tape: Comply with Section 26-05-19.
3. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
4. Use identification labels or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
5. Use underground warning tape to identify underground raceways.
6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

E. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color-coded boxes to identify systems other than normal power system.
    a. Color-Coded Boxes: Field-painted in accordance with Section 09-91-23 and 09-91-13 per the same color code used for raceways.
3. Use identification labels to identify circuits enclosed.

F. Identification for Devices:
1. Wiring Device and Wall plate Finishes: Comply with Section 26-27-26.
2. Factory Pre-Marked Wall plates: Comply with Section 26-27-26.
3. Use identification label or engraved wall plate to identify serving branch circuit for all receptacles.
4. Use identification label or engraved wall plate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

G. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
    a. Brimar Industries, Inc: www.brimar.com.
    b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
    c. Seton Identification Products: www.seton.com.

2. Materials:
    a. Indoor Clean, Dry Locations: Use plastic nameplates.
    b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. 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.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. 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.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
    a. Use only for indoor locations.
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) Emergency Power System: Identify with text "EMERGENCY".
        2) Fire Alarm System: Identify with text "FIRE ALARM".
    b. Equipment designation or other approved description.
    c. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
    a. System Designation: 1 inch.
    b. Equipment Designation: 1/2 inch.
    c. Other Information: 1/4 inch.
    d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
    a. Normal Power System: White text on black background.
    b. Emergency Power System: White text on red background.
    c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.
    a. Exceptions:
        1) Provide white text on red background for general information or operational instructions for emergency systems.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

A. Manufacturers:
1. Brady Corporation: www.bradyid.com.
2. HellermannTyton: www.hellermanntyton.com.
3. Panduit Corp: www.panduit.com.

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.

2.04 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

C. 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.

D. Legend:
1. Markers for Voltage Identification: Highest voltage present.
2. Markers for System Identification:
a. Emergency Power System: Text "EMERGENCY".

E. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

A. Manufacturers:
   1. Brady Corporation: www.bradyid.com.
   2. Brimar Industries, Inc: www.brimar.com.
   3. Seton Identification Products: www.seton.com.

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:
   1. Tape for Buried Power Lines: Black text on red background.
   2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.06 WARNING SIGNS AND LABELS

A. Manufacturers:
   1. Brimar Industries, Inc: www.brimar.com.
   2. Clarion Safety Systems, LLC: www.clarionsafety.com.
   3. Seton Identification Products: www.seton.com.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. 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.
      a. Do not use labels designed to be completed using handwritten text.
   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.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 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. Conduits: Legible from the floor.

8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: As follows.
    a. Receptacles: Outside face of cover.
    b. Switches: Inside face of cover - concealed from view.

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.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

B. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

END OF SECTION 26-05-53

SECTION 26-05-83

WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

A. Section 26-05-19 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26-05-33.13 - Conduit for Electrical Systems.

C. Section 26-05-33.16 - Boxes for Electrical Systems.

D. Section 26-27-26 - Wiring Devices.

E. Section 26-28-16.16 - Enclosed Switches.

1.03 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices.

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.

C. NFPA 70 - National Electrical Code.

1.04 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.
   3. Verify equipment voltage corresponds with the voltage and phase that will be supplied to the equipment. Do not connect if there is a discrepancy in voltage or phase.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

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

PART 2 PRODUCTS

2.01 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 26-28-16.16 and in individual equipment sections.

C. Wiring Devices: As specified in Section 26-27-26.

D. Flexible Conduit: As specified in Section 26-05-33.13.

E. Wire and Cable: As specified in Section 26-05-19.

F. Boxes: As specified in Section 26-05-33.16.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 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. Make conduit connections to equipment at the point of entry to the equipment cabinet using appropriate conduit fittings. Do not route conduits through cabinet openings.

D. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

E. Provide receptacle outlet to accommodate connection with attachment plug.

F. Provide cord and cap where field-supplied attachment plug is required.

G. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

H. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

I. Install terminal block jumpers to complete equipment wiring requirements.

J. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

K. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION 26-05-83

SECTION 26-24-16

PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Lighting and appliance panelboards.

B. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

A. Section 26-05-26 - Grounding and Bonding for Electrical Systems.

B. Section 26-05-29 - Hangers and Supports for Electrical Systems.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NECA 407 - Standard for Installing and Maintaining Panelboards.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NEMA PB 1 - Panelboards.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

H. NFPA 70 - National Electrical Code.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

K. UL 67 - Panelboards.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

M. UL 869A - Reference Standard for Service Equipment.

N. UL 943 - Ground-Fault Circuit-Interrupters.

O. UL 1699 - Arc-Fault Circuit-Interrupters.

1.04 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 of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

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

B. 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.

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

D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

1.06 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.

1.07 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.

1.08 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. 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.

2.02 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.

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 solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
3. 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. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
c. Provide removable end walls for NEMA Type 1 enclosures.
d. 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. 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. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

L. Load centers are not acceptable.

M. Provide the following features and accessories where indicated or where required to complete installation:
1. Feed-through lugs.
2. Sub-feed lugs.

2.03 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 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.

2.04 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:
         1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2) 14,000 rms symmetrical amperes at 480 VAC.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   3. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Lug Material: Copper, suitable for terminating copper conductors only.
   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.
      a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
      b. Provide interchangeable trip units where indicated.
   5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
      a. Provide the following field-adjustable trip response settings:
         1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
         2) Long time delay.
         3) Short time pickup and delay.
         4) Instantaneous pickup.
         5) Ground fault pickup and delay where ground fault protection isindicated.
      b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
   6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
   7. Provide the following circuit breaker types where indicated:
      a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
      b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
      c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
      d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
      e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
   8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.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.
   12. Provide the following features and accessories where indicated or where required to

complete installation:

a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
d. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.05 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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.

3.02 INSTALLATION

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

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

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

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

E. Provide required supports in accordance with Section 26-05-29.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. 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.

I. 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.

J. Provide grounding and bonding in accordance with Section 26-05-26.

K. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.

L. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

M. Install all field-installed branch devices, components, and accessories.

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

A. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

B. Set field-adjustable circuit breaker tripping function settings as indicated.

C. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

D. Provide filler plates to cover unused spaces in panelboards.

E. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing

essential loads where indicated. Also provide for the following:

1. Emergency and night lighting circuits.
2. Fire detection and alarm circuits.
3. Communications equipment circuits.
4. Intrusion detection and access control system circuits.
5. Video surveillance system circuits.

3.03 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. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section

D. 7.6.1.1 for all main circuit breakers and circuit breakers larger than 800 amperes. Tests listed as optional are not required.

E. 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.

F. Test GFCI circuit breakers to verify proper operation.

G. Test AFCI circuit breakers to verify proper operation.

H. Test shunt trips to verify proper operation.

I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 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.

3.05 CLEANING

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

END OF SECTION 26 24 16

SECTION 26-27-26

WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Receptacles.

B. Wall plates.

1.02 RELATED REQUIREMENTS

A. Section 26-05-33.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

C. NEMA WD 1 - General Color Requirements for Wiring Devices.

D. NEMA WD 6 - Wiring Devices - Dimensional Specifications.

E. NFPA 70 - National Electrical Code.

F. UL 498 - Attachment Plugs and Receptacles.

G. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.

H. UL 943 - Ground-Fault Circuit-Interrupters.

1.04 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 installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   4. Notify Engineer 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.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

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

C. Operation and Maintenance Data:
   1. GFCI Receptacles: Include information on status indicators.

D. Project Record Documents: Record actual installed locations of wiring devices.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

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

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 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.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: Ivory with stainless steel wall plate.

C. Wiring Devices Installed in Finished Spaces: Ivory with stainless steel wall plate.

D. Wiring Devices Installed in Unfinished Spaces: Ivory with galvanized steel wall plate.

E. Wiring Devices Installed in Wet or Damp Locations: Ivory with specified weatherproof cover.

2.03 RECEPTACLES

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com.
   2. Leviton Manufacturing Company, Inc: www.leviton.com.
   3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. 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.

C. Convenience Receptacles:
   1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   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.

D. 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.
   2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
   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.

2.04 WALL PLATES

A. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Oversized.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

C. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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.

3.02 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.

3.03 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26-05-33.16 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
   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 Engineer to obtain direction prior to proceeding with work.
   5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Install wiring devices plumb and level with mounting yoke held rigidly in place.

I. Install wall switches with OFF position down.

J. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

K. 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.

L. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

3.04 FIELD QUALITY CONTROL

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

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Inspect each surface protection receptacle to verify surge protection is active.

G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26-27-26

SECTION 26-28-13

FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 RELATED REQUIREMENTS

A. Section 26-28-16.16 - Enclosed Switches: Fusible switches.

1.03 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses.

B. NFPA 70 - National Electrical Code.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.

D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.

E. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.

F. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
      a. Fusible Enclosed Switches: See Section 26-28-16.16.
   2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
   3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.06 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. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

D. Products: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com.

B. Cutler-Hammer.

C. GE Company.

D. Littelfuse, Inc: www.littelfuse.com.

2.02 APPLICATIONS

A. Service Entrance:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

B. Feeders:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

C. General Purpose Branch Circuits: Class RK1, time-delay.

D. Individual Motor Branch Circuits: Class RK1, time-delay.

E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

F. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

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

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

H. Class L Fuses: Comply with UL 248-10.

I. Class CC Fuses: Comply with UL 248-4.

J. Main Service Switches Larger than 600 amperes: Class L (time delay) current limiting with 200,000 amp interrupting rating..

K. Main Service Switches 600A and less: Class RK1 or J (time delay), current limiting with 200,000 amp interrupting rating.

L. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay), current limiting with 200,000 amp interrupting rating.

M. Power Load Feeder Switches 600A and less: Class RK1 (time delay), current limiting with 200,000 amp interrupting rating.

N. Motor Load Feeder, Motor Controller & Transformer Circuit Switches: Class RK5, current limiting with 200,000 amp interrupting rating.

O. Individual Equipment Switches where fault current does not exceed 50,000A: Class K5 with 50kA interrupting rating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

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

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Coordinate fuse sizes for equipment with the nameplate of the equipment being protected. The equipment supplied on the project may be different from the equipment originally specified.

D. Replace all fuses that blow during construction after correcting the problem that caused the overload condition.

END OF SECTION 26-28-13

SECTION 26-28-16.16

ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 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.

D. Section 26-28-13 - Fuses.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

H. UL 98 - Enclosed and Dead-Front Switches.

I. UL 869A - Reference Standard for Service Equipment.

1.04 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 of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

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

D. Project Record Documents: Record actual locations of enclosed switches.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 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.

1.07 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. 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.

2.02 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. Number of Poles: Suitable for the load served.
   1. When a manufacturer does not offer a configuration compatible with the load served in Heavy Duty construction, furnish a 3-pole switch to meet the intent of the specification. Do not substitute General Duty switches under any circumstances.

G. Short Circuit Current Rating:
   1. 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.
   2. Minimum Ratings:
      a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.
      b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
      c. Double Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.

H. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

I. Provide with switch blade contact position that is visible when the cover is open.

J. 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.

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

L. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

M. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

N. 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:

O. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

P. Heavy Duty Switches:
   1. Comply with NEMA KS 1.
   2. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Provide compression lugs where indicated.
      c. 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.

Q. 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.
   2. Integral fuse pullers.
   3. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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.

3.02 INSTALLATION

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

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

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. Mount controllers to walls or suitable structures. Do not mount to equipment. Where equipment is not located near a suitable wall or suitable structure, field fabricate a support structure and mount the controller to the structure. For exterior applications, fabricate structure from hot dipped galvanized strut materials and use hot dipped galvanized fasteners.

G. 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.

H. Provide grounding and bonding in accordance with Section 26-05-26.

I. Provide fuses complying with Section 26-28-13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

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

K. Identify enclosed switches in accordance with Section 26-05-53.

3.03 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 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

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

3.05 CLEANING

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

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

END OF SECTION 26-28-16.16

SECTION 26-29-13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
   2. General purpose contactors.
   3. Manual motor starters.
   4. Motor-starting switches without overload protection.

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

C. Manual motor controllers.

D. Magnetic motor controllers.

E. Combination magnetic motor controllers and disconnects.

1.02 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.

D. Section 26-28-13 - Fuses: Fuses for fusible switches.

1.03 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.

E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures.

G. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

I. NFPA 70 - National Electrical Code.

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

K. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules.

L. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contractors and Motor-starters - Electromechanical Contractors and Motor-starters.

1.04 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 required by NFPA 70.
   2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
   3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

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

B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

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

D. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

F. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

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

H. Maintenance Data: Replacement parts list for controllers.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc.. as necessary for a complete operating system.

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

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:

1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
    a. Altitude:
        1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
        2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
    b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:

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

G. Enclosures:
1. Comply with NEMA ICS 6.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
3. Finish: Manufacturer's standard unless otherwise indicated.

H. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

I. Magnetic Motor Starters: Combination type unless otherwise indicated.
1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
2. Configuration: Full-voltage non-reversing unless otherwise indicated.
3. Disconnects: Circuit breaker type.
    a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.
    b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
    c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
4. Overload Relays: Bimetallic thermal type unless otherwise indicated.

J. Manual Motor Starters:
1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
2. Configuration: Non-reversing unless otherwise indicated.

K. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.03 OVERCURRENT PROTECTIVE DEVICES

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

a. Interchangeable current elements/heaters.
b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
c. Trip test function.

B. Circuit Breakers:
1. Interrupting Capacity (not applicable to motor circuit protectors):
a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Motor Circuit Protectors:
a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
b. Provide field-adjustable magnetic instantaneous trip setting.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

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

C. Control and Timing Relays:
1. Comply with NEMA ICS 5.
2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 10 VA spare capacity.
2. Include primary and secondary fuses.

2.05 MANUAL CONTROLLERS

A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, NO auxiliary contact, and push button operator.

B. Fractional Horsepower Manual Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and key operator.

C. Motor Starting Switches: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and key operator.

D. Enclosures: NEMA ICS 6, Type 1.

2.06 AUTOMATIC CONTROLLERS

A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

B. Two-Speed Controllers: Include integral time delay transition between FAST and SLOW speeds.

C. Coil Operating Voltage: 120 volts, 60 Hertz.

D. Overload Relays: NEMA ICS 2; bimetal.

E. Enclosures: NEMA ICS 6, Type 1.

2.07 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.

B. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty oil-tight type.

C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.

D. Pushbuttons: Recessed type.

E. Indicating Lights: Transformer, incandescent type.

F. Selector Switches: Rotary type.

G. Control Power Transformers: 120 volt secondary, 10 VA minimum, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.08 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.

C. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole; UL listed.

D. Nonfusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.

E. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Install controllers in accordance with NECA 1 (general workmanship).

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

D. Provide required support and attachment components in accordance with Section 26-05-29.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26-05-26.

G. Install all field-installed devices, components, and accessories.

H. Mount controllers to walls or suitable structures. Do not mount to equipment. Where equipment is not located near a suitable wall or suitable structure, field fabricate a support structure and mount the controller to the structure. For exterior applications, fabricate structure from hot dipped galvanized strut materials and use hot dipped galvanized fasteners.

I. Provide fuses complying with Section 26-28-13 for fusible switches as indicated.

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

K. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

L. Select and install overload heater elements in motor controllers to match installed motor characteristics.

M. Identify enclosed controllers in accordance with Section 26-05-53.

3.02 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. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 800 amperes. Tests listed as optional are not required.

E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

F. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION 26-29-13

SECTION 26-51-00

INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Exit signs.

D. Ballasts and drivers.

E. Lamps.

F. Luminaire accessories.

1.02 RELATED REQUIREMENTS

A. Section 26-05-33.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

A. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society.

D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction.

F. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems.

G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems.

H. NFPA 70 - National Electrical Code.

I. NFPA 101 - Life Safety Code.

J. UL 924 - Emergency Lighting and Power Equipment.

K. UL 1598 - Luminaires.

L. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 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 of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

B. 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.

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

D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 70 and NFPA 101.

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

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

E. Suitable for Use in Fire Rated Ceilings: For luminaires installed in fire rated ceiling assemblies, include label identifying the fixture is listed for use in a fire rated ceiling.

1.07 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.

1.08 FIELD CONDITIONS

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

1.09 WARRANTY

A. Provide three year manufacturer warranty for all LED luminaires, including drivers.

B. Provide five year pro-rata warranty for batteries for emergency lighting units.

C. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.01 MANUFACTURERS - LUMINAIRES

A. Acuity Brands, Inc: www.acuitybrands.com.

B. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com.

C. Hubbell Lighting, Inc: www.hubbelllighting.com.

D. Manufacturers of fixtures, lamps and ballasts must have a minimum of 5 years successful experience in the manufacture of the applicable product.

2.02 LUMINAIRES

A. Manufacturers:
   1. Acuity Brands, Inc: www.acuitybrands.com.
   2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com.
   3. Hubbell Lighting, Inc: www.hubbelllighting.com.
   4. Philips Lighting North America Corporation; www.lightingproducts.philips.com.

B. Furnish products as indicated in Schedule included on the Drawings.

C. NEC Article 417.73 Note: Provide disconnecting means to satisfy the NEC requirements for luminaire disconnecting means for ballasted fixtures with double ended lamps and luminaires with ballasts fed from multiwire circuits.

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

E. Provide products that are listed and labeled as complying with UL 1598, where applicable.

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

G. 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.

H. 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.

I. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

J. 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.

2.03 EMERGENCY LIGHTING UNITS

A. Manufacturers:
   1. Acuity Brands, Inc: www.acuitybrands.com.
   2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com.
   3. Hubbell Lighting, Inc: www.hubbelllighting.com.

B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

C. 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.

D. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

F. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 EMERGENCY EXIT LUMINAIRE

A. Manufacturers:
   1. Acuity Brands, Inc: www.acuitybrands.com.
   2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com.
   3. Hubbell Lighting, Inc: www.hubbelllighting.com.
   4. Philips Lighting North America Corporation; www.lightingproducts.philips.com/#lse.

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.

D. Exit Signs: Exit sign fixture suitable for use as emergency lighting unit.
1. Provide fixtures complying with NFPA 101.
2. Housing: Extruded aluminum.
3. Style: Aluminum stencil face with red letters.
4. Housing: Extruded aluminum.
5. Lamps: Compact fluorescent.
6. Directional Arrows: Universal type for field adjustment.
7. Mounting: Universal, for field selection.
8. Battery: Battery must be high temperature rated (0C-60C) maintenance free type, with 1.5 hour capacity.
    a. Self contained maintenance free unit with a normal life expectancy of 10 years.
    b. Battery must power the connected fixture lamps for a minimum of 90 minutes.
    c. Resealable sintered pressure vent.
    d. Positive and negative terminal.
9. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.
    a. Fully automatic solid state type, full wave rectifying, with current limiting feature.
    b. Charger shall restore the battery to full charge within 24 hours after a discharge of 90 minutes under full rated load.
    c. The charger shall be activated when the battery voltage drops below 80%.
    d. A low voltage disconnect switch shall be included if a lead battery is used to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage
10. Lamps: LED. Maximum LED failure rate shall be 25% within a seven year period. If this failure rate is exceeded, the manufacturer shall replace the complete unit at no charge.
11. Additional Features:
    a. Pilot light to indicate the unit is connected to AC power.
    b. The battery shall have a high rate charge pilot light unless it is the self diagnostic type.
    c. Test switch to simulate operation of the unit upon loss of AC power by energizing the lamps from the battery and exercising the transfer relay.
12. Special Warranty Requirements:
    a. The entire unit shall be warranted for three years. The battery must have an additional two years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty paperwork shall be included in the contract close-out documents.

2.05 EMERGENCY EGRESS LUMINAIRE

A. Emergency Lighting Units: Luminaire suitable for use as emergency lighting unit.
1. Housing: Plastic.
2. Mounting: Universal, for field selection.
3. Battery: Battery must be 12 volt high temperature rated (0C-60C) maintenance free type, with 1.5 hour capacity.
    a. Self contained maintenance free unit with a normal life expectancy of 10 years.
    b. Battery must power the connected fixture lamps for a minimum of 90 minutes.
    c. Resealable sintered pressure vent.
    d. Positive and negative terminal.
4. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.

a. Fully automatic solid state type, full wave rectifying, with current limiting feature.
b. Charger shall restore the battery to full charge within 24 hours after a discharge of 90 minutes under full rated load.
c. The charger shall be activated when the battery voltage drops below 80%.
d. A low voltage disconnect switch shall be included if a lead battery is used to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage

5. Lamps: Halogen incandescent lamps shall be supplied with the unit.
6. Additional Features:
   a. Pilot light to indicate the unit is connected to AC power.
   b. The battery shall have a high rate charge pilot light unless it is the self diagnostic type.
   c. Test switch to simulate operation of the unit upon loss of AC power by energizing the lamps from the battery and exercising the transfer relay.
7. Special Warranty Requirements:
   a. The entire unit shall be warranted for three years. The battery must have an additional two years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty paperwork shall be included in the contract close-out documents.

2.06 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

B. Stepped dimming LED drivers for connection to existing wall switches: Provide separate conductor for lighting circuit voltage input from hardwired switchlegs to operate fixtures at 50% output with one switchleg energized and 100% power with both switchlegs energized.

2.07 LAMPS

A. Lamps - General Requirements:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

B. Lamp Types: As specified for each fixture.

C. Fluorescent Lamps:
   1. Lamps shall comply with the EPA Guidelines regarding the Toxicity Characteristic Leaching Procedure (TCLP).

D. Reflector Lamps: Beam patterns in accordance with ANSI C78.379.

2.08 ACCESSORIES

A. Accessories: As specified or as otherwise required for each luminaire.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

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.

3.02 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.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26-05-33.16 as required for installation of luminaires provided under this section.

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

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

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. 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 lay-in luminaires to ceiling support channels using listed safety clips at four corners.
   4. 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.
   5. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

G. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).

H. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

I. Support luminaires from the building steel independent of ceiling framing.

J. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

K. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

L. Exposed Grid Ceilings: Support surface mounted and lay-in luminaires in grid ceiling directly from building structure. Support each fixture with four dedicated support wires securely attached to each corner of the fixture. The support wires shall be installed a maximum of 15 degrees from vertical. Provide additional intermediate steel secured to the building structure where the building structural elements do not accommodate the fixture support requirements listed above. Secure lay-in fixtures to the grid main runners at the four corners using sheet metal screws.

M. Install recessed luminaires flush with ceiling surface. For lay-in ceilings, support the fixture from building stee with a dedicated support wire at each corner of the fixture. Furnish intermediate building steel when the steel framing of the building is not located near the fixture.

N. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

O. Install clips to secure recessed grid-supported luminaires in place.

P. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Drawings.

Q. Install accessories furnished with each luminaire.

R. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within fixture; use flexible conduit.

S. Connect luminaires and exit signs to branch circuit outlets provided under Section 26-05-37 using flexible conduit.

T. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

U. Bond products and metal accessories to branch circuit equipment grounding conductor.

V. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

W. Provide all attachments and intermediate steel as required to provide support members for luminaires. Do not support fixtures from steel joist bridging - bridging is not considered to be a load carrying portion of the building steel.

X. 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.

Y. 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.

Z. Install lamps in each luminaire.

3.04 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, emergency lighting units, and fluorescent emergency power supply 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 Engineer.

F. Test exit and emergency lighting units for proper operation after they have charged for at least 24 hours by disconnecting power from the unit and observing operation for the full 90 minute minimum test cycle. Repair or replace any unit that fails the test until all units have passed the test. Perform this test at least 10 days prior to final inspection. Record the results of the test for each unit and include the report in the close-out documentation. The test shall demonstrate that the batteries conform to the requirements of NEC 700.12(F).

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. 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 Engineer 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 Engineer or authority having jurisdiction.

D. Aim and adjust fixtures as directed.

E. Position exit sign directional arrows as indicated.

3.06 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.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.07 CLOSEOUT ACTIVITIES

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

B. Replace defective ballasts and drivers as indicated by failure to fire lamps, or excessive noise, heat, or odors.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.09 SCHEDULE - SEE DRAWINGS

END OF SECTION 26-51-00

SECTION 31 31 16

TERMITE CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chemical soil treatment for termite control.

B. Related Requirements:
   1. Section 03 30 00 - Cast-In-Place Concrete: Slabs on grade placed over treated soil.

1.2 REFERENCES

A. U.S. Environmental Protection Agency (EPA):
   1. EPA Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); 2006.

1.3 SEQUENCING

A. Section 01 30 00 - Administrative Requirements and Section 00 10 00 - Summary: Scheduling and sequencing.

B. Apply toxicant 12 hours prior to installation of vapor barrier under slabs-on-grade in accordance with product label supplemented by the NPCA’s ARP for termiticiding or local requirements.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data:
   1. Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate. Include product label information.
   2. Submit manufacturers' data on manufactured products showing compliance with specified requirements.

C. Test Reports: Indicate regulatory agency approval reports.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Certificate of compliance from authority having jurisdiction indicating approval of toxicants.

F. Manufacturer's Instructions: Indicate caution requirement.

G. Manufacturer’s Qualifications.

H. Installer’s Qualifications.

I. Maintenance Data: Indicate re-treatment schedule.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 78 23 - Operation and Maintenance Data.

B. Project Record Documents: Record and document the following:
   1. Moisture content of soil before application.
   2. Date and rate of application.
   3. Areas of application and diary of toxicity meter readings and corresponding soil coverage.

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

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing this type of work and:
   1. Having minimum of five (5) years documented experience.
   2. Approved by manufacturer of treatment materials.
   3. Licensed in the State in which the Project is located.

1.7 WARRANTY

A. Section 01 77 00 - Closeout Procedures: Product warranties.

B. Provide five (5) year installer's warranty against damage to building caused by termites.
   1. Include coverage for repairs to building and to contents damaged due to building damage. Repair damage and re-treat areas.
   2. Include provision for installer to inspect and report annually to Owner in writing for duration of warranty period.

PART 2 PRODUCTS

2.1 CHEMICAL SOIL TREATMENT

A. Toxicant Chemical: Registered (licensed) by EPA; approved in accordance with Title 7, United States Code, 136 through 136y - FIFRA; approved by local authority having jurisdiction; synthetically color dyed to permit visual identification of treated soil.

B. Diluent: Recommended by toxicant manufacturer.

C. Manufacturers:
   1. BASF.
   2. Bayer Environmental Science Corporation.
   3. Corteva Agriscience.
   4. FMC Specialty Solutions.
   5. Syngenta Professional Products.
   6. Substitutions: Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 - Execution: Verification of existing conditions before starting work.

B. Verify soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.

C. Verify final grading and excavations are complete.

D. Prepare field conditions and existing construction for installation of work of this Section.

E. Prepare materials to be installed and equipment used during installation.

3.2 APPLICATION - CHEMICAL SOIL TREATMENT

A. Section 01 73 00 - Execution: Related to installation of Work.

B. Comply with requirements of U.S. EPA and applicable state and local codes.

C. Comply with manufacturer's written instructions.

D. Mix toxicant in accordance with manufacturer’s instructions.

E. Record and maintain Project Record Documents indicated in CLOSEOUT SUBMITTALS article of this Section.

F. Spray apply toxicant in accordance with manufacturer's instructions.

G. Apply toxicant at following locations:

1. Under slabs-on-grade.
2. In crawl spaces.
3. At both sides of foundation surface.
4. Soil within 5 feet of building perimeter for a depth as recommended by manufacturer.
5. Other locations as indicated on Drawings.

H. Under slabs, apply toxicant immediately prior to installation of vapor barrier.

I. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.

J. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.

K. Re-treat disturbed treated soil with same toxicant as original treatment.

L. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.3 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 73 00 - Execution: Protecting installed construction.

B. Do not permit soil grading over treated work.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes chain link fences and gates.

1.2 REFERENCES

A. ASTM International (ASTM):
1. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a, Reapproval 2022.
2. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fabric; 2011, Reapproval 2022.
3. ASTM A824 - Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence; 2001, Reapproval 2022.
4. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2023.
5. ASTM F626 - Standard Specification for Fence Fittings; 20114, Reapproval 2023.
6. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric; 2017, Reapproval 2022.
7. ASTM F900 - Standard Specification for Industrial and Commercial Steel Swing Gates; 2011, Reapproval 2017.
8. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials; 1996, Reapproval 2022.
9. ASTM F1043 - Standard Specification for Strength and Protective Coatings of Steel Industrial Fence Framework; 2018, Reapproval 2022.
10. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2018, Reapproval 2022.
11. ASTM F1345 - Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric; 2010a, Reapproval 2023.
12. ASTM F1664 - Standard Specification for Poly (Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence; 2008, Reapproval 2022.

B. Chain Link Fence Manufacturers Institute (CLFMI):
1. CLFMI CLF-SFR0111 - Security Fencing Recommendations.
2. CLFMI CLF TP0211 - Tested and Proven Performance of Security Grade Chain Link Fence Systems.
3. CLFMI WLG 2445 - Chain Link Fence Wind Load Guide For The Selection Of Line Post And Line Post Spacing; 2023.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Provide data on fabric, posts, accessories, fittings, and hardware.

C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. Refer to CLFMI CLF-SFR0111 for planning and design recommendations.

D. Samples: Submit two (2) samples of each of the following, sized to illustrate construction and finishes.

1. Chain Link fabric.
2. Color: Manufacturer's full range of colors and finishes for Architects selection.
   a. Color options for products requiring color finishes.

E. Manufacturer's Qualification Statement.

F. Fence Installer Qualification Statement.

G. Project Record Documents: Provide drawings that accurately record actual surveyed locations of installed fencing relative to property lines.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five (5) years of documented experience.

B. Fence Installer Qualifications: Company with successful experience installing similar projects and products, with not less than five (5) years of documented experience.

1.5 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Minimum requirements to be as recommended by product manufacturer unless requirements indicated in this Section are more stringent.

C. Storage: Store and protect products off the ground and as required to protect products from damage.

1.6 WARRANTY

A. Section 01 77 00 - Closeout Procedures: Product warranties.

B. Manufacturer Warranty: Provide five (5) year warranty to replace products that exhibit failure due to manufacturing workmanship or fabrication.

C. Fence Installer Warranty: Provide five (5) year warranty to correct and replace defective work.

D. Warranty Period: Warranty periods are for duration indicated and are to begin on the Date of Substantial Completion.

PART 2 PRODUCTS

2.1 CHAIN LINK FABRIC

A. Steel Chain Link Fabric:
   1. Fabric Height: Height to be measured for finish grade.
      a. As indicated on Drawings.
   2. Mesh Size:
      a. 2 inch (51 mm) diamond mesh interwoven wire.
   3. Wire Thickness:
      a. 9 gauge, 0.1483 inch (3.8 mm) thick.
   4. Fabric Selvage:
      a. K&K: Top selvage knuckle end closed; bottom selvage knuckle end closed.
   5. Finish:
      a. Zinc-Coated Steel Fabric: ASTM A392 hot dipped galvanized after weaving.
         1) Class 2 - 2.0 oz/sf.

b. Polymer Coated Steel Fabric Finish: Complying with ASTM F668. Wire thickness specified is the core wire thickness. PVC coating thickness is to be as follows:
   1) Class 2b fused and adhered (powder coat), 0.008 to 0.010 inch thick coating.
   2) Color: In compliance with ASTM F934.
      a) As selected by Architect.

2.2 STEEL FENCE FRAMEWORK

A. Round Steel Pipe And Rail.
   1. Heavy Industrial Fence Framework. ASTM F1083, schedule 40 galvanized pipe. ASTM F1043 Group IA.
      a. Grade: ASTM F1043.
         1) Regular Grade, 30,000 psi yield strength.
      b. Exterior hot dipped zinc coating minimum:
         1) 1.8 oz/sf.
      c. Interior hot dipped zinc coating minimum:
         1) 1.8 oz/sf.
   2. Fence Line Post: 1.90 inches OD.
   3. Fence End, Corner, Pull Post: 2.375 inches OD.
   4. Fence Top, Bottom, Brace, and Intermediate Rails: 1.660 inches OD.
   5. Swing Gate Hinge Post: 2.875 inches OD.
   6. Swing Gate Frame Members: 1.90 inches OD.
   7. Polymer Coated Framework Finish:
      a. PVC coating; fused and adhered (powder coat) to the exterior zinc coated post or rail; PVC minimum thickness 0.010 inch (10 mil) (0.254 mm).
      b. Color: Match chain link fabric.

2.3 TENSION WIRE

A. Metallic Coated Steel Tension Wire: Marcelled wire complying with ASTM A824.
   1. Wire Thickness: 7 gauge (0.177 inch) (4.50 mm) thick.
   2. Metallic Coating:
      a. Type II, Zinc-Coated:
         1) Class 5 - 2.0 oz/sf.
   3. Polymer Coated Steel Tension Wire Finish: Wire thickness specified is the core wire thickness.
      a. PVC coating is to comply with ASTM F1664 with coating thickness as follows:
         1) Class 2b fused and adhered (powder coat), 0.008 to 0.010 inch thick coating.
      b. Color: Match chain link fabric.

2.4 FITTINGS

A. Tension and Brace Bands: Comply with ASTM F626, galvanized pressed steel, minimum steel thickness of 12 gauge (0.105 inch) (2.67 mm), minimum width of 3/4 inch (19 mm), and minimum zinc coating of 1.20 oz/sf. Carriage bolts to be 5/16 inch or 3/8 inch galvanized steel.

B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: Comply with ASTM F626, galvanized pressed steel, galvanized after fabrication having a minimum zinc coating of 1.20 oz/sf.

C. Truss Rod Assembly: Comply with ASTM F626, 3/8 inch (9.53 mm) diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.20 oz/sf, assembly capable of withstanding a tension of 2,000 lbs. (970 kg).

D. Tension Bars: Comply with ASTM F626. Galvanized steel one-piece length 2 inch (50 mm) less than the fabric height. Minimum zinc coating 1.20 oz. /sf.
   1. Bars for 2 inch (50 mm) and 1-3/4 inch (44 mm) mesh are to have a minimum cross section of 3/16 inch (4.8 mm) by 3/4 inch (19 mm).

E. Polymer Coated Fittings Finish: Comply with ASTM F626. Polymer coating minimum thickness 0.006 inch (0.152 mm) fused and adhered (powder coat) to zinc coated fittings.
   1. Color: Match chain link fabric.

2.5 TIE WIRE AND HOG RINGS

A. Tie Wire: Comply with ASTM F626.
   1. 9 gauge (0.148 inch) (3.76 mm) aluminum alloy.

B. Hog Rings: Comply with ASTM F626.
   1. 9 gauge (0.148 inch) (3.76 mm) aluminum alloy.

C. Polymer Coated Tie Wire and Hog Rings Finish: Comply with ASTM F626. Polymer coating minimum thickness 0.006 inch (0.152 mm) fused and adhered (powder coat) to zinc coated fittings.
   1. Color: Match chain ling fabric.

2.6 SWING GATES

A. Swing Gates: Comply with ASTM F900.
   1. Frame Member: As indicated in STEEL FENCE FRAMEWORK article in this Section. Fully welded joints. Hot dipped galvanized after fabrication. Polymer coating, if indicated, to be applied after galvanizing process.
   2. Height: Top and bottom to match chain link fence.
   3. Width: As indicated on Drawings.
   4. Hardware: Galvanized steel fabrications; finish color, type and application to match fence system components. Center mounted.
      a. Hinges: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates.
      b. Latches and Keepers:
         1) Single Gate: Fork latch with gravity drop and padlock hasp. Keeper to hold gate in fully open position.
         2) Double Gate: Drop bolt on inactive leaf engaging receiver socket. Receiver socket is to be set in concrete, flush with surround grade or hard surface. Active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.

2.7 CONCRETE

A. Concrete for post footings shall have a 28-day compressive strength of 2,500 psi.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 - Execution: Verification of existing conditions before starting work.

B. Verify that field measurements are as required.

C. Verify that surfaces and conditions are ready to accept the Work of this Section.

D. Examine products to be installed for damage and other conditions detrimental to completion of the Work.

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

3.2 PREPARATION

A. Section 01 73 00 - Execution: Prepare field conditions and existing construction for installation of Work of this Section.

B. Provide surveying, clearing, grubbing, grading, and removal of debris from the fence line and required clear areas adjacent to the fence.

C. Prepare materials to be installed and equipment to be used during installation.

3.3 INSTALLATION - GENERAL

A. Section 01 73 00 - Execution: Related to installation of Work.

B. Install the Work in compliance with the design requirements, applicable codes, manufacturer's recommendations, and the Contract Documents.

3.4 FRAMEWORK INSTALLATION

A. Posts: Posts are to be set plumb in concrete footings in accordance with ASTM F567 or the Drawings, whichever requirement is more stringent.
   1. Minimum footing depth to be 24 inches, plus an additional 3 inches for each 1 foot increase in the fence height over 4 feet. Minimum footing diameter to be four times the largest cross section of the post up to 4 inches OD and three times the largest cross section of post greater than 4 inches OD. Gate posts require larger footings; minimum requirements are listed in ASTM F567.
   2. Top of post concrete footing to be 4 inches below grade and crowned to shed water away from the post.
   3. Line posts are to be installed at intervals not exceeding 10 feet on center.

B. Top Rail: Install 21 foot lengths of rail continuous through the line post loop tops. Splice rail using top rail sleeves minimum 6 inches long. The rail is to be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard bands or rail ends and brace bands.

C. Terminal Posts: End, corner, pull and gate posts are to be braced and trussed for fence 6 feet and higher and for fences 5 feet in height not having a top rail. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.

D. Tension Wire: Install 4 inches up from the bottom of the fence fabric. Fences without top rail are to have a tension wire installed 4 inches down from the top of the chain link fabric. Tension wire is to be stretched taut, independently and prior to the chain link fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to the chain link fabric with 9 gauge hog rings at 18 inches on center and to each line post with a tie wire.

3.5 CHAIN LINK FABRIC INSTALLATION

A. Install chain link fabric to outside of the framework. Attach chain link fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and carriage bolts spaced no greater than 12 inches on center.

B. Chain link fabric is to be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches on center and to rail spaced no greater than18

inches on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches apart.

C. Installed chain link fabric is to have a ground clearance of 2 inches.

D. Excess wire is to be cut off and bent over to prevent injury.

3.6 GATE INSTALLATION

A. Install swing gates and gateposts in compliance with ASTM F567. Direction of swing is to be as indicated on Drawings. Gates shall be plumb in the closed position having a bottom clearance of 3 inches. Hinge and latch offset opening space from the gate frame to the post to be no greater than 3 inches in the closed position. Double gate drop bar receivers are to be set in a concrete footing minimum 6 inches in diameter and 24 inches deep. Install gate leaf holdback hardware.

3.7 NUTS AND BOLTS

A. Carriage bolts used for fittings are to be installed with the head on the outside of the fence.

3.8 ADJUSTING

A. Section 01 73 00 - Execution: Starting, testing, adjusting, and balancing.

B. Adjust operating components to be free of binding and for smooth, quiet operation.

3.9 CLEANING

A. Section 01 73 00 - Execution and Section 01 77 00 - Closeout Procedures: Clean installed work in accordance with manufacturer’s recommendations including cleaning procedures and materials.

B. Clean surfaces soiled by work as recommended by manufacturer of soiled substrate.

C. Clean work area and restore areas and surfaces damaged by the installation operations.

3.10 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 73 00 - Execution: Protecting installed construction.

END OF SECTION