BIDDING REQUIREMENTS, CONTRACT CONDITIONS AND SPECIFICATIONS

for the renovation and general construction of

HERITAGE HILLS ELEMENTARY SCHOOL NO. 9
& SOUTH SPRING CANYON NO. 10

For Canyon Independent School District
CONTRACT CONDITIONS AND SPECIFICATIONS FOR
THE GENERAL CONSTRUCTION OF HERITAGE HILLS ELEMENTARY SCHOOL
NO. 9 & SOUTH SPRING CANYON NO. 10
FOR CANYON INDEPENDENT SCHOOL DISTRICT

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01 July 2019

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Canyon ISD ES #9 & #10
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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe, fittings, valves, and connections for combination sprinkler and standpipe systems.

B. Related Sections:

1. Division 3 - Concrete Forming and Accessories: Execution requirements for inserts and sleeves specified by this section.
2. Division 9 - Painting and Coating: Execution requirements for piping painting specified by this section.

1.2 REFERENCES

1. American Society of Mechanical Engineers:
   2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
   4. ASME B16.3 - Malleable Iron Threaded Fittings.
   5. ASME B16.4 - Gray Iron Threaded Fittings.
   6. ASME B16.5 - Pipe Flanges and Flanged Fittings.
   8. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

B. ASTM International:


C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:


E. National Fire Protection Association:
   2. NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants and Hose Systems.
   3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

1.3 SUBMITTALS
   A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
   B. Product Data: Submit manufacturer’s catalogue information. Indicate valve data and ratings.
   C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS
   A. Project Record Documents: Record actual locations of components and tag numbering.
   B. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver and store valves in shipping containers, with labeling in place.
   B. Furnish cast iron and steel valves with temporary protective coating.
   C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.1 VALVES
   A. Gate Valves:
1. Up to and including 2 inches: Bronze body and trim, rising stem, hand wheel, solid wedge or disc, threaded ends.
2. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid bronze or cast iron wedge, flanged ends.
3. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends.

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

C. Ball Valves:
   1. Up to and including 2 inches: Stainless steel two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle, threaded ends.
   2. Over 2 inches: Manufacturers: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive hand wheel for sizes 10 inches and over, flanged.

D. Butterfly Valves:
   1. Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, hand wheel and gear drive and integral indicating device.
   2. Cast or Ductile Iron Body: Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends. With extended neck, hand wheel and gear drive and integral indicating device, and external tamper switch rated 10 amp at 115 volt AC.

E. Check Valves:
   1. Up to and including 2 inches: Bronze body and swing disc, rubber seat, threaded ends.
   2. Over 2 inches: Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends.
   3. 4 inches and Over: Iron body, bronze disc with stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

F. Drain Valves:
   1. Compression Stop: Bronze with hose thread nipple and cap.
   2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

2.2 BURIED PIPING

   1. Fittings:
b. Mechanical Joint AWWA C153 Compact Ductile Iron.

2. Restraints at Ductile Iron Fittings: A split serrated ring shall be used to grip the plain-end of the pipe, a sufficient number of bolts shall connect the restraint ring to the ductile iron fitting. The restraint for mechanical joint fittings shall be the Series 19MJ00. The restraint for push-on fittings with restraining ears shall be the 19PF00.

a. Restraints at couplings: The restraint shall be manufactured of ductile iron conforming to ASTM A536. A split ring shall be utilized on the PVC fitting bell. A serrated ring shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring. The combination shall have a minimum working pressure rating equivalent to the pipe.

B. Marking

1. Pipe and couplings shall be legibly and permanently marked in ink with the following minimum information:
   a. Pipe
      • Nominal size
      • PVC
      • Dimension ratio (for example, DR18)
      • AWWA/UL pressure class (for example, PC 235)
      • AWWA C900-07 (or latest edition)
      • Manufacturer’s name or trademark and production record code
      • Seal(mark) of the testing agency verifying the suitability of the pipe material for potable water service
      • Seal (mark) of the certifying agencies that have tested and approved the pipe for use in fire protection systems
   b. Couplings
      • Nominal size
      • PVC
      • AWWA/UL pressure class (for example, PC 305)
      • AWWA C900-07 (or latest edition)
      • Manufacturer’s name or trademark
      • Seal (mark) of the testing agency verifying the suitability of the pipe material for potable water service
      • Seal (mark) of the certifying agencies which have tested and approved the pipe for use in fire protection systems.

2.3 ABOVE GROUND PIPING – AFTER SYSTEM RISER

A. Steel Pipe: ASTM A135/135M UL listed, threadable, light wall;

B. Schedule 10 black for pipe sizes 2-1/2 inches and larger.

C. Schedule 40 black for pipe sizes 2 inches and smaller.

4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
5. Mechanical Formed Fittings: Carbon-steel housing with integral pipe stop and O-ring pocked and O-ring uniformly compressed into permanent mechanical engagement onto pipe.

2.4 BELOW GROUND PIPING – AFTER SYSTEM RISER

A. Cast Iron Pipe: AWWA C151.
   1. Fittings: AWWA C110, standard thickness.

2.5 DOUBLE CHECK ASSEMBLY BACKFLOW PREVENTER

A. Manufacturer: Ames, Watts
B. Double Check Valve Assemblies:
   1. ANSI/ASSE 1015 for vertical applications
   2. 300 series stainless steel body with corrosion resistant internal parts, rubber faced disk, and stainless steel springs and cam arms;
   3. Two independently operating spring loaded cam-check valves with intermediate atmospheric vent and test cocks.
   4. Wedge type resilient seated isolation valves

2.6 PIPE HANGERS AND SUPPORTS

A. Conform to 2013 NFPA 13.
B. Hanger rod:
   1. Mild steel threaded both ends, threaded on one end, or continuous threaded.
   2. Galvanized
C. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
D. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
F. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
G. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
H. Vertical Support: Steel riser clamp.
I. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and foreign material, from inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install piping in accordance with NFPA 13 for sprinkler systems.
B. All piping upstream of the backflow preventer shall meet the requirements of NFPA 24 for service mains.
C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
D. Install piping to conserve building space, to not interfere with use of space and other work.
E. Group piping whenever practical at common elevations.
F. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.
G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
H. Pipe Hangers and Supports:
   1. Install in accordance with NFPA 13.
   2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00.
      a. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
I. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.
J. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
K. Do not penetrate building structural members unless indicated.

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

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

N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.

O. Install butterfly valves for shut-off or isolating service.

P. Install drain valves at main shut-off valves, low points of piping and apparatus.

3.3 CLEANING

A. Clean entire system after other construction is complete.

END OF SECTION – 21 00 00
SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes wet-pipe sprinkler system, system design, installation, and certification.

1.2 REFERENCES
A. National Fire Protection Association:

1.3 SYSTEM DESCRIPTION
A. System to provide coverage for entire building.
B. Provide hydraulically designed system to 2013 NFPA 13 light hazard occupancy requirements for entire building.
C. Determine volume and pressure of incoming water supply from water flow test data.
D. Interface system with building fire and smoke alarm system.
E. Provide fire department connections as indicated on Drawings.

1.4 SUBMITTALS
A. Shop Drawings: Indicate layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation. Indicate detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
B. Product Data: Submit data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Design Data: Submit design calculations
D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS
A. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
B. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE
A. Perform Work in accordance with 2013 NFPA 13.

1.7 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
B. Installer: Company specializing in performing Work of this section with minimum three years experience.
C. Design system under direct supervision of Licensed Fire Protection Designer experienced in design of this Work and licensed in State of Texas.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Store products in shipping containers until installation.
B. Furnish piping with temporary inlet and outlet caps until installation.

1.9 EXTRA MATERIALS
B. Furnish suitable wrenches for each sprinkler type.
C. Furnish metal storage cabinet located adjacent to alarm valve.

PART 2 PRODUCTS

2.1 SPRINKLERS
A. Suspended Ceiling Type:
   1. Type: Listed quick response type, Concealed pendant type with matching push on escutcheon plate.
   2. Finish: Enamel, color white.
   3. Escutcheon Plate Finish: Enamel, color white.
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type:
1. Type: Listed quick response, standard upright type.
2. Finish: Enamel, color white.
3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Sidewall Type:
   1. Type: Listed quick response concealed horizontal side wall type with matching push on escutcheon plate and guard.
   2. Finish: Enamel, color white.
   3. Escutcheon Plate Finish: Enamel, color white.
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

D. Guards: Finish to match sprinkler finish.

2.2 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim; with test and drain valve.

B. Electric Alarm: 24V, Electrically operated red enameled gong with pressure alarm switch.

C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

D. Remote Fire Department Connections:
   1. Type: Free standing with brass body and polished chrome plated finish.
   2. Outlets:
      a. Number of outlets as required by NFPA 13.
      b. Fire department thread size.
      c. Threaded dust cap and chain of matching material and finish.
   4. Label: "Sprinkler - Fire Department Connection".

E. Supervisory Switches: As manufactured by Potter.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 13.

B. Install equipment in accordance with manufacturer’s instructions.

C. Install approved back-flow preventer assembly at sprinkler system water source connection.

D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle.

E. Locate outside alarm-gong on building wall
F. Place pipe runs to minimize obstruction to other work.

G. Install piping in concealed spaces above finished ceilings.

H. Center sprinklers in two directions in ceiling tile and install piping offsets.

I. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

J. Install guards on sprinklers

K. Hydrostatically test entire system.

L. Require test be witnessed by Fire Marshal.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Verify signal devices are installed and connected to fire alarm system.

3.3 CLEANING

A. Flush entire piping system of foreign matter.

END OF SECTION – 21 13 13
SECTION 22 00 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 – GENERAL

1.1 SPECIAL NOTE

A. The Architectural, Structural, Mechanical and Electrical Plans and Specifications, including the supplements issued thereto, Information to Bidders, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying mechanical plans. All the above is included herewith, will be issued separately or is on file at the Architect's office, for examination by all bidders. Omission of drawings will not relieve the Contractor of responsibility or be used as a basis for additional compensation.

1.2 CHECKING DOCUMENTS

A. The drawings and the specifications are numbered consecutively. Check all drawings and specifications thoroughly and notify the Engineer of any discrepancies or omissions of sheets or pages. Upon notification, the Architect or Engineer will provide the Contractor with any missing portions of the drawings or specifications.

1.3 LAWS, CODES AND ORDINANCES

A. Performance all work in accordance with the codes listed below as well as the codes of any other legal body having jurisdiction, as interpreted by the inspecting authority.

1. 2015 International Building Code (IBC)
2. 2015 International Mechanical Code (IMC)
3. 2015 International Plumbing Code (IPC)
4. 2015 International Fire Code (IFC)
5. 2015 International Energy Conservation Code (IECC)
6. Americans with Disabilities Act (ADA)
7. Texas Accessibility Standards (TAS)
8. US Department of Labor
9. Occupational Safety and Health Administration's (OSHA) Occupational Safety and Health Standards.

B. Where these specifications and the accompanying drawings conflict with these requirements, report the matter to the Engineer for clarification.

1.4 AMERICANS WITH DISABILITIES ACT (ADA) / TEXAS ACCESSIBILITY STANDARDS (TAS)

A. Install all work to conform with the requirements of the Americans with Disabilities Act (ADA) and the Texas Accessibility Standards (TAS). Where conflicts occur between these two standards, the TAS shall govern.

B. Obtain documentation referencing these standards and install work in strict accordance with them. Before installing any work where it is unclear as to the exact requirements of the standards, obtain a ruling from the Architect or Engineer for an interpretation of the requirements.
C. The following is a general outline of requirements for mechanical and plumbing items. These items are for general reference only. Consult the original standard for exact requirements. These items include but are not limited to the following:

1. Drinking Fountains and Water Coolers:
   a. Adults - primary users are 16 years and older: Lower fountain spout mounted at 36 inches above floor.
   b. Grades Pre-K through 5: Lower fountain spout mounted at 32 inches above floor, maintain 26 inches knee clearance.

2. Water Closets - flush controls:
   a. In all cases, whether the flush device is a flush valve or a flush tank, install the device such that the flush controls are mounted on the wide side of the toilet area.
   b. Install so that flush controls are no higher than 44 inches above the floor.

3. Urinals
   a. Adults - primary users are 16 years and older: Mount fixture with rim 17 inches above floor. Fixtures have 14 inch tapered elongated rim.
   b. Grades Pre-K through 5: Mount fixture with rim 14 inches above floor. Fixtures have 14 inch tapered elongated rim.

4. Lavatories and Sinks:
   a. Adults - primary users are 16 years and older: Mount fixture with rim 34 inches above floor. Maintain 29 inches clearance under rim.
   b. Grades Pre-K through 5: Mount fixture with rim 30 inches above floor. Maintain 26 inches clearance under rim.

5. Lavatories and Sinks - exposed pipes and surfaces:
   a. Insulate water supplies and risers as well as p-traps and tailpieces with pre-formed insulating covers.
   b. Install offset tailpieces to maintain knee clearance at least 27 inches high and 19 inches deep.

1.5 GENERAL

A. In general, the lines and ducts to be installed by the various trades under these specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of various lines and ducts and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. All piping and ductwork for the mechanical trade shall be concealed in chases in finished areas, except as indicated on the drawings. Horizontal lines run in areas that have ceilings shall be run concealed in those ceilings, unless otherwise specifically indicated or directed.
C. Piping and ductwork may be run exposed in machinery and equipment spaces, where serving as connections to motors and equipment items in finished rooms where exposed connections are required, and elsewhere as indicated on the drawings or required.

D. All conduits in any space where they are exposed shall run parallel with the building walls. They shall enter the concealed areas perpendicular with the walls, ceilings or floors. Fittings shall be used where necessary to comply with this requirement.

E. The plumbing plans do not give exact details as to elevations of lines and ducts, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other installation details. Carefully lay out work at the site to conform to the architectural and structural conditions, to provide proper grading of lines, to avoid all obstruction, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

F. The mechanical plans do not give exact locations of outlets, fixtures, equipment items, etc. Determine the exact location of each item by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections.

G. The Contractor is responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Engineer. The Contractor shall make such necessary changes at his own expense.

H. Order of precedence shall be observed in laying out the pipe, ductwork, and material in order to fit the material into the space above the ceiling and in the chases and walls. The following order shall govern:

1. Lines requiring grade to function such as sewers.
2. Large ducts and pipes with critical clearances.
3. Conduit, water lines, and other lines whose routing is not critical and whose function would not be impaired by bends and offsets.
4. Items affecting the visual appearance of the inside of the building such as diffusers, grilles, etc. Coordinate all items to avoid conflicts at the site.

I. The Contractor understands that the work described herein and shown on the accompanying drawings results in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

J. Examine the plans and specifications for the General Construction. If these documents show any item requiring work under Division 22 and that work is not indicated on the respective "P" drawings, notify the Engineer in sufficient time to clarify before bidding.

1.6 DIMENSIONS

A. Before ordering any material or doing any work, verify all dimensions, including elevations, and be responsible for the correctness of the same. Submit any difference found to the Engineer for consideration before proceeding with the work.

1.7 MANUFACTURER'S DIRECTIONS
A. All manufactured articles shall be applied, installed and handled as recommended by the manufacturer.

1.8 MATERIALS AND WORKMANSHIP

A. All materials are new unless otherwise specified and of the quality specified. All materials of a type for which the Underwriters Laboratories, Inc. have established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Wherever the make of material or apparatus required is not definitely specified, submit a sample to the Engineer before proceeding.

C. The Engineer reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Engineer's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection.

1.9 SUBSTITUTION OF MATERIALS

A. Where a definite material of a specific manufacturer is mentioned in these specifications, it has been done in order to establish a standard of quality of the product or item to be used on the project.

B. It is recognized that acceptable materials are offered by manufacturers other than those named in the specifications. All request for substitution of materials, products and equipment shall be made in writing to the Engineer at least five working days prior to the bid date. Requests made after that time or not made in writing will not be considered.

C. Furnish complete descriptive literature and complete operation and performance data on all substitute materials.

D. Include in the information a complete list of deviations of the requested item from the specified item.

E. The Engineer will investigate such requests for substitutions, and issue any acceptance of substitution by addendum.

F. Substitutions which are requested and which are allowed will be made known by the Engineer in addendum form prior to bid.

G. Approval to substitute an item does not constitute acceptance of the product to be used on the project or the omission of the submittal process.

1.10 SUBMITTAL PROCEDURES

A. NOTE: Submittals not in compliance with the following requirements will be summarily rejected.

B. Schedule submittals to expedite the Project, and deliver to Architect/Engineer. Coordinate submission of related items.
C. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.

D. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.

E. When revised for re-submission, identify all changes made since previous submission.

F. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

G. Submittal Format:

1. Submit all shop drawings at one time.
2. Bind in a three-ring binder or pressboard report cover with prong paper fasteners.
3. Identify Project, Architect, Engineer, Contractor, subcontractor and supplier.
4. Index each section according to the specifications and separate from other sections.
5. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
6. Provide a 2 inch x 5 inch space for the Engineer's review stamp.

H. Product Data:

1. Product data to be job specific.
2. Catalogue cut sheets providing only generic information will not be accepted.
3. Equipment selections shall indicate actual performance of equipment, corrected for jobsite conditions, altitude, temperature and pressures.
4. Submit to Architect/Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents. Provide copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes.
5. Submit the number of copies which the Contractor requires, plus two copies which will be retained by the Architect/Engineer.
6. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
7. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
8. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents.

I. Manufacturer's Instructions:

1. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Architect/Engineer for delivery to Owner in quantities specified for Product Data.
2. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

J. Manufacturer's Field Reports:
1. Submit reports for the Architect/Engineer's benefit as contract administrator or for the Owner.
2. Submit report within 30 days of observation to Architect/Engineer for information.
3. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the Contract Documents.

1.11 PROTECTION OF APPARATUS

A. Take precautions necessary to properly protect new apparatus from damage. Erect temporary shelters to adequately protect any apparatus stored in the open on the site. Crib apparatus above the floor of the construction. Cover apparatus in the incomplete building with tarpaulins or other protective covering. The Engineer reserves the right to reject any equipment or component which has not been properly protected.

1.12 PERMITS, FEE, ETC.

A. Arrange for a permit from the local authority. Arrange for all utility services, including sewer, water, gas and electric services as applicable. Pay any charges made by any of the utility companies due to the work on this project, including charges for metering, connection, street cutting, etc. Pay any inspection fees or other fees and charges required by ordinance, law, codes and these specifications.

1.13 TESTING

A. Perform the various tests as specified and required by the Engineer and as required by the State and local authorities. Furnish all fuel and materials necessary for making tests.

1.14 CLEANING

A. At all times during the progress of the work, keep the premises clean and free of unnecessary materials and debris. Clear any designated areas or area of materials and debris. On completion of any portion of the work, remove from the premises all tools and machinery and all debris occasioned by the work, leaving the premises free of all debris and construction dust.

1.15 COORDINATION OF Trades

A. Items furnished under Division 22 which require electrical connections shall be coordinated with Division 26 for:

1. Voltage
2. Phase
3. Ampacity
4. No. and size of wires
5. Wiring diagrams
6. Starter size, details and location
7. Control devices and details

B. Coordinate items furnished under various sections which require plumbing connections for services, pressure, size and location of connections, type of fuel, clearances for service, auxiliary devices required, etc.

C. Insulation shall be checked against manufacturer's directions and job requirements for suitability, coverage, thickness and finish.
D. Coordinate items installed in/on finished ceilings with the ceiling construction. Conform to the reflected ceiling plan and secure details and/or samples of the ceiling materials as necessary to insure compatibility.

E. Install all items specified tight, plumb, level, square and symmetrically placed in relation to the work of other trades.

1.16 CUTTING AND PATCHING

A. Perform all construction modification and cutting required to install the work. No cutting of any structural member is permitted without specific permission from the Engineer.

B. Patching shall be done by the Contractor under the section for which the trade is specified.

1.17 PAINTING

A. All painting shall be done by the Contractor under Division 9. Following is a general outline of the required work for Divisions 22.

1. When the factory finish on any apparatus or equipment is marred, touch up and give one coat of half flat half enamel, followed by a coat of machinery enamel of a color to match the original. Paint factory primed surfaces.

2. Paint all exposed pipe, conduit, boxes, cabinets, hangers and supports and miscellaneous metal.

3. Paint all exposed sheet metal.

4. Paint all insulated surfaces exposed to view, including piping, equipment, etc. Size surfaces until a smooth, non grainy surface is obtained.

B. Generally, painting is required on all surfaces such that no exposed bare metal or insulation surface is visible.

1.18 SEALING AROUND PIPES, CONDUITS, DUCTS, ETC.

A. Seal all spaces between pipes and/or sleeves where they pierce walls, partitions or floors as specified in sections 07 84 13 and 07 84 46.

1.19 ACCESS PANELS

A. Wherever mechanical and/or electrical equipment is installed and where future access is required through either walls or ceilings and such cannot be obtained through the removable ceiling or through other means, provide Milcor Style "M" access doors at least 12 inches by 12 inches in size or larger if required for access. Provide access doors for all fire dampers, smoke dampers, valves, etc.

1.20 USE OF SYSTEMS

A. New Installations:

1. Under no circumstances shall any of the plumbing equipment or fixtures be used during construction, except for proving operation.
2. Immediately prior to the time that the systems are to be accepted by the Owner, carefully examine each system and if any components are dirty, clean by men skilled in that type of work.

1.21 ROUGH-IN AND MAKE FINAL CONNECTION FOR EQUIPMENT

A. The shop drawings for all equipment are hereby made a part of these specifications. Rough-in for the exact item to be furnished on the job, whether in another section of the specifications or by the Owner. Refer to all drawings and other sections of the specifications for the scope of work involved for the new equipment, and by actual site examination determine the scope of the required equipment connections for the Owner furnished equipment.

B. Should any of the equipment furnished require connections of a nature different from that shown on the drawings, report the matter to the Engineer and finally connect as directed by the Engineer.

1.22 OPERATING INSTRUCTIONS

A. In cooperation with the representatives of the manufacturers of the various equipment items, carefully instruct the Owner's representatives in the proper operation of each item of equipment and of each system during the balancing and adjusting of systems.

1.23 OPERATING MANUALS

A. Prepare and submit 3 copies of the operating manuals bound in hard covers.

B. Include the following data:

1. Catalogue data of all equipment.
2. Shop drawings of all equipment.
3. Start-up instructions for major equipment.
4. Trouble shooting procedures for major equipment.
5. Wiring diagrams.
6. Recommended maintenance schedule for equipment.
7. Parts list for all items.
8. Name and address of each vendor.

1.24 GUARANTEE

A. Unless a longer guarantee is hereinafter called for, all work, material and equipment items shall be guaranteed for a period of one year after acceptance by the Owner. All defects in labor and materials occurring during this period shall be repaired and/or replaced. Guarantee shall be in writing and in triplicate.

1.25 COMPLETION REQUIREMENTS

A. Before acceptance and final, furnish:

1. Accurate record drawings, shown in red ink on blue line prints furnished for that purpose all changes from the original plans made during installation of the work.
2. All manufacturers' guarantees.
3. All operating manuals.
END OF SECTION 22 00 00
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following systems:

1. Domestic water piping.
2. Sanitary sewer piping.
3. Storm water piping.
4. Natural gas piping.
5. Equipment drains and overflows.
6. Unions and flanges.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
4. Section 22 05 23 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
6. Section 22 07 00 - Plumbing Insulation: Product requirements for piping insulation for placement by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.3 – Malleable Iron Threaded Fittings.
2. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.26 – Cast Bronze Fittings for Flared Copper Tubes.
5. ASME B16.29 – Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
7. ASME B36.10M – Welded and Seamless Wrought Steel Pipe.

B. ASTM International:

1. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
2. ASTM A234/A234M - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
5. ASTM B68 - Seamless Copper Tube
18. ASTM D 1784 Standard Specification for Rigid PVC Compounds and Chlorinated PVC Compounds
21. ASTM F 477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. Cast Iron Soil Pipe Institute:


D. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

E. NSF International:

1. NSF 61 Drinking Water System Components – Health Effects

1.3 SUBMITTALS

A. Section 220000: Submittal procedures.

B. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
1.4 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing work of this section.

1.5 QUALITY ASSURANCE
   B. Valves: Manufacturer's name and pressure rating marked on valve body.
   C. Welding Materials and Procedures: Conform to ASME SEC IX.
   D. Identify pipe with marking including size, ASTM material classification, ASTM specification, water pressure rating.

1.6 REGULATORY REQUIREMENTS
   A. Perform Work in accordance with International Plumbing Code and local amendments.
   B. Conform to State code for installation of backflow prevention devices.
   C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
   B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

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

1.9 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED
   A. PVC Pipe: Schedule 40, ASTM D2665 or ASTM D3034.
1. Fittings: ASTM D3311, Schedule 40, PVC.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

A. PVC Pipe: Schedule 40, ASTM D2665 or ASTM D3034
   1. Fittings: PVC.

2.3 DOMESTIC WATER PIPING, BURIED FROM METER TO BUILDING

A. Copper Tubing: ASTM B42, hard drawn, type K.

B. All piping and fittings provided shall be from the same manufacturer. Mixing in materials provided by different manufacturers is prohibited.

2.4 WATER PIPING, BELOW SLAB (IN KITCHEN AREA ONLY)

A. Manufacturer: Rehau Raupex non-insulated piping

B. Carrier Pipe: Cross-linked polyethylene (PEX) water distribution pipe shall be third-party certified to standards NSF 14/61, ASTM F 876 and F 877, and CSA B 137.5.
   1. Pipe shall be certified by PPI to standard TR-3.
   2. Pipe shall be certified by ICC Evaluation Service.
   3. Pipe shall be certified by the IAPMO Plumbing Research Committee and shall be marked with the UPC Shield.

C. Piping to be color coded – blue for domestic cold water, red for domestic hot water.

D. All hot-and cold-water distribution pipe shall have a minimum pressure rating of 160 psi at 73.4°F, 100 psi at 180°F and 80 psi at 200°F.

E. Pipe to be manufactured using the high-pressure peroxide method with a minimum degree of cross-linking of 80% when tested in accordance with ASTM D 2765, Method B.

F. Pipe to be tested for resistance to hot chlorinated water in accordance with ASTM F 2023. Pipe to have a minimum extrapolated time-to-failure of 50 years, calculated in accordance with section 13.3 of F 2023.

G. Pipe to have a Flame Spread Index of less than 25, and a Smoke Developed Index of less than 50, when tested in accordance with ASTM E 84.

H. Pipe to be manufactured in an ISO 9001 certified production facility.

I. The minimum bend radius for cold bending of the pipe shall be not less than five (5) times the outside diameter.

J. Fittings:
1. All fittings used with cross-linked polyethylene (PEX) water distribution pipe intended for plumbing applications shall be of the cold-expansion compression-sleeve design in accordance with ASTM F 2080.
2. Fittings shall be certified to standards NSF 61, ASTM F 2080 and CSA B 137.5.
3. Fittings shall be certified by ICC Evaluation Service.
4. Fittings shall be certified by the IAPMO Plumbing Research Committee and shall be marked with the UPC Shield.
5. Fittings to have minimum inside diameter of 82% of inside pipe diameter.

K. Markings:
1. Pipe to carry the following markings every three (3) feet:
   a. Manufacturer’s name or trademark, nominal size, PEXa (material designation), SDR9 (standard dimension ratio), ASTM F 876 / F 877 / F 2023 / F2080, CSA B137.5, NSF-pw, UPC Shield, 160 psi @ 73.4°F / 100 psi @ 180°F / 80 psi @ 200°F, POTABLE TUBING, manufacturing date, and footage mark.
2. Pipe to have consecutive footage marks every 3 feet.

2.5 DOMESTIC WATER PIPING, ABOVE GRADE
A. Copper Tubing: ASTM B88, Type L, drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.
B. All piping and fittings provided shall be from the same manufacturer. Mixing in materials provided by different manufacturers is prohibited.

2.6 STORM WATER PIPING, BURIED
A. PVC Pipe: Schedule 40, ASTM D2665 or ASTM D3034.
   1. Fittings: ASTM D3311, Schedule 40, PVC.

2.7 STORM WATER PIPING, ABOVE GRADE - CONCEALED
A. PVC Pipe: Schedule 40, ASTM D2665 or ASTM D3034
   1. Fittings: PVC.

2.8 STORM WATER PIPING, ABOVE GRADE – ALL EXPOSED AREAS
A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

2.9 NATURAL GAS PIPING, BURIED
A. Polyethylene Pipe: ASTM D2513, SDR 11.5.
1. Fittings: ASTM D2683 or ASTM D2513 socket type.

2.10 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53 Schedule 40 black.
   2. Joints: NFPA 54, threaded or welded to ANSI B31.1

2.11 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type L, drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, solder.

B. All piping and fittings provided shall be from the same manufacturer. Mixing in materials provided by different manufacturers is prohibited.

2.12 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 300, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered.
   3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
   4. PVC Piping: PVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Copper Piping: Class 150, slip-on bronze flanges.
   3. PVC Piping: PVC flanges.

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

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify trenches are ready to receive piping.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.
D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS
A. Verify connection size, location, and invert are as indicated on Drawings.
B. Establish elevations of buried piping with not less than 2 ft of cover.
C. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches loose depth.
D. Install pipe on prepared bedding.
E. Route pipe in straight line.
F. Install pipe to allow for expansion and contraction without stressing pipe or joints.
G. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
H. Install trace wire continuous over top of pipe. above pipe line; coordinate with Section. Refer to Section 22 05 53.
I. Pipe Cover and Backfilling:
   1. Maintain optimum moisture content of fill material to attain required compaction density.
   2. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
   3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
   4. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING
A. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
C. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
D. Group piping whenever practical at common elevations.
E. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. 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 00.

H. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08.

I. Install non-conducting dielectric connections wherever jointing dissimilar metals.

J. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.

K. Slope piping and arrange systems to drain at low points.

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

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

N. Install valves in accordance with Section 22 05 23.

O. Insulate piping. Refer to Section 22 07 00.

P. Install pipe identification in accordance with Section 22 05 53.

3.5 TESTING

A. Test all pipes before they are concealed in furrings or chases, insulated, painted, or otherwise covered up or rendered inaccessible.

B. Accomplish testing by sections of lines or systems, as required by conditions during construction. Clean all piping and equipment before testing.

C. Domestic Water Lines Interior:
   1. Hydrostatically test for 6 hours at 150 psig. There shall be no leaks whatsoever.

D. Interior Soil, Waste and Vent Lines:
   1. Test with water before the fixtures are installed.
   2. Water test applied to the drainage and venting system either in its entirety or in sections.
   3. Entire system testing:
      a. tightly close all openings in piping system except the highest opening
      b. Fill system with water to the point of overflow.
   4. Sectional system testing:
      a. Plug each opening except the highest opening of the section under test
      b. Fill system to be tested with water to achieve a 10 foot head on the portion under test.
      c. Keep water in the system, or in the portion under test, for at least 30 minutes before the inspection starts.
   5. Water shall not drop more than 1 inch in 8 hours.
E. Gas Lines:
   1. Test with 50 psig air pressure for 24 hours with no pressure drop (except for temperature correction). If any drop occurs, soap test all joints, correct leaks and retest.

F. Downspouts and Storm Drains:
   1. Fill system to be tested with water to achieve a 10 foot head
   2. Keep water in the system for at least 30 minutes before the inspection starts.
   3. System shall be tight at all joints with no leaks whatsoever.

3.6 UNDERGROUND PIPING VIDEO INSPECTION

A. General: Perform video inspection of underground sewer piping from the point of connection to the manhole outside the building through the mains and through the single takeoff to each fixture.

B. Contractor Qualifications: Inspection shall be conducted by a Contractor who has at least 2 years experience in the specific work involved.

C. Certification: Provide statement of certification of the following:
   1. Verification of video inspection contractor qualifications.
   2. Statement of completion that the work is in accordance with the specified requirements.
   3. Name and signature of the General Contractor.
   4. Name and signatures of the video inspection subcontractor.

D. Video Taping Requirements:
   1. Video camera designed for express purpose of sewer line inspection.
   2. Camera and apparatus capable of extending to all points of piping required within 2 inch to 8 inch diameter pipe.
   3. Video recording with on-screen distance counter.
   4. Taping shall include expert narrative of situations encountered which may be associated with improper installation or operation of the sewer. Audio commentary shall include time and date, location description in an on-to-from format, size of sewer, direction of flow, and video tape identification number.
   5. Taping shall produce clear, sharp, images in DVD format.
   6. Tape shall identify date, time, and precise location of taping operations. Tape shall reveal evidence of surrounding area around each entry point.

E. Procedure:
   1. Inspect sewer pipes with video camera no earlier than 30 days after floor slab has been poured. Sections of sewer determined to be deficient shall be uncovered and repaired or replaced to satisfaction of Owner. Retest repaired section.
   2. Adequately flush and clean sewer piping prior to video inspection.
   3. Provide additional video inspection at contractor’s expense if there are clogging problems within the first year warranty and if requested by owner.

F. Report:
1. Provide summary report of pipes inspected and defects noted. Report shall be in MS Word format. The log shall show the exact measure location of faults such as, but not limited to:
   a. Open joints, Broken, cracked or collapsed pipe
   b. Accumulation of debris or obstructions
   c. Evidence of infiltration
   d. Water depth variation and sags
   e. Protrusions

2. The reference location shall include the distance away from the reference point of entry such as manhole or cleanout and the position of the fault as to the bottom, top, or side of the pipe.

3. Significant faults are to warrant audio commentary on the video tape duplication report information. Stop the camera briefly at these locations.

4. Furnish one copy of the final report with one copy of video tapes to the Engineer within one week after completion of the inspection.

5. Video tapes shall be numbered and cross indexed to the report. Report shall be bound.

6. Provide plan of piping network covered with notations and identification of corresponding tape.

3.7 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 2 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

I. After domestic water lines have been sterilized and flushed, they shall be tested and certified by the Bi-County Health Department. A copy of the test results shall be forwarded to the Owner.

   1. If contamination is found, the disinfection procedure shall be repeated.

3.8 SERVICE CONNECTIONS

A. Coordinate gas service with the gas utility. Gas service distribution piping to have initial minimum pressure of 2 psi. Provide regulators as shown on the drawings, sized in accordance with equipment loads indicated.
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backflow preventers
2. Water hammer arrestors
3. Cleanouts
4. Floor Drains
5. Floor Sinks
6. Grease Interceptors

B. Related Sections:

1. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
2. Section 22 05 23 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
4. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
5. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.

1.2 REFERENCES

A. American National Standards Institute:


B. American Society of Sanitary Engineering:

1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
2. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
3. ASSE 5013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers (RP) and Reduced Pressure Fire Protection Principle Backflow Preventers (RFP).

C. ASTM International:


D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

E. Plumbing and Drainage Institute:


1.3 SUBMITTALS

A. Section 22 00 00: Submittal procedures.

B. Product Data:

1. Hangers and Supports: Submit manufacturers catalog information including load capacity.
2. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
3. Drain Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

C. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and equipment.
B. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.5 QUALITY ASSURANCE
A. For drinking water service, provide valves complying with NSF 61.

1.6 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Section 22 00 00: Product storage and handling requirements.
B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.
C. Provide temporary protective coating on cast iron and steel valves.
D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS
A. Section 01 - Product Requirements.
B. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 ROOF DRAINS
A. Manufacturer: Wade Series W-3000.
B. Other acceptable manufacturers offering equivalent products.
   1. Zurn Z-100.
C. Assembly: ANSI A112.21.2.
D. Body: Lacquered cast iron with sump.
E. Strainer: Removable cast iron dome.

F. Accessories: Coordinate with roofing type
   1. Membrane flange and membrane clamp with integral gravel stop.
   2. Adjustable under deck clamp.
   3. Waterproofing flange.
   4. Adjustable extension sleeve for roof insulation.
   5. Perforated or slotted ballast guard extension for inverted roof.
   6. Perforated stainless steel ballast guard extension.

2.2 ROOF OVERFLOW DRAINS

A. Manufacturer: Wade Model W-3000-D.

B. Other acceptable manufacturers offering equivalent products.
   1. Zurn Z-100-W2.

C. Lacquered cast iron body and clamp collar and bottom clamp ring; integral cast iron dam extended to 2 inches above top of roof.

D. Assembly: ANSI A112.21.2.

E. Strainer: Removable cast iron dome.

F. Accessories: Coordinate with roofing type
   1. Membrane flange and membrane clamp with integral gravel stop.
   2. Adjustable under deck clamp.
   3. Waterproofing flange.
   4. Adjustable extension sleeve for roof insulation.
   5. Perforated or slotted ballast guard extension for inverted roof.
   6. Perforated stainless steel ballast guard extension.

2.3 DOWNSPOUT NOZZLES

A. Manufacturer: Wade Model W-3940.

B. Other acceptable manufacturers offering equivalent products.
   1. Zurn Z-199.

C. Cast bronze with threaded inlet and wall flange.

2.4 BACKFLOW PREVENTERS

A. Manufacturers:
   1. Watts Model LF909

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

2.5 WATER HAMMER ARRESTORS

A. Manufacturers:
   1. Sioux Chief, PPP

B. ASSE 1010; copper construction, piston type sized in accordance with PDI WH-201.

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

2.6 CLEANOUTS

A. Exterior Areas:
   1. Manufacturer:
      a. Wade W-6000Z
      b. Zurn Z-1400-HD

B. Round cast iron, threaded adjustable housing, flanged ferrule with plug and round nickel bronze scored tractor top

C. Interior Finished Floor Areas:
   1. Manufacturer:
      a. Wade W-6000
      b. Zurn Z-1400
      2. PVC body with anchor flange, threaded top assembly, and round scored cover with gasket in service areas and round depressed cover with gasket to accept floor finish in finished floor areas.
         a. Carpeted areas: with carpet flange: Wade W-6000-CF
         b. Poured or synthetic floor areas: wide flange top: Wade W-6000-D
         c. Tile floor: square top: Wade W-6000-TS
         d. Terrazzo Floor: no flange: Wade W-6000-U

D. Interior Finished Wall Areas:
   1. Manufacturer:
      a. Wade W-8560-E, with 8480-R cover
      b. Zurn Z-1446
      2. Line type with PVC body and round cover, and round stainless steel access cover secured with machine screw.

2.7 FLOOR DRAINS – FD

A. Manufacturers:
   1. Wade Model W-1100.
2. Zurn Model Z-415-B.

B. ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

C. Accessories:
   1. Provide each floor drain with elastomeric PVC duckbill insert as manufactured by Trap Guard®.

2.8 3 INCH FLOOR SINKS – 3” FS

A. Manufacturers:
   1. Wade Model W-9110
   2. Zurn Model Z-1910

B. 8x8x6 lacquered cast iron body with aluminum dome strainer, A.R.E. interior and seepage flange with 3/4 satin nickel bronze top.

C. Accessories:
   1. Provide each floor drain with elastomeric PVC duckbill insert as manufactured by Trap Guard®.
   2. Provide floor sinks with round or elongated funnels where indicated on drawings.

2.9 4 INCH FLOOR SINKS – 4” FS

A. Manufacturers:
   1. Wade Model W-9140
   2. Zurn

B. 12x12x8 lacquered cast iron body with aluminum dome strainer, A.R.E. interior and seepage flange with 3/4 satin nickel bronze top.

C. Accessories:
   1. Provide each floor drain with elastomeric PVC duckbill insert as manufactured by Trap Guard®.
   2. Provide floor sinks with round or elongated funnels where indicated on drawings.

2.10 GREASE INTERCEPTOR

A. Manufacturer: Vaughn Concrete Products.

B. Construction:
   1. 4" precast 4000 psi concrete with rebar reinforcing, two compartment, 1000 gallon capacity. Factory installed crossover pipe between compartments.
   2. Provide with 24" diameter openings in tank top at each end and 18" diameter removable inspection lid over divider, inlet and outlet opening with pipe seals ready to accept field piping.
   3. Provide with 8" precast concrete traffic rated lid.
4. Provide with 24” i.d. manhole risers, gas tight cast iron rings and covers.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

B. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION

A. Install water hammer arrestors on hot and cold water supply piping to lavatories, sinks, washing machine supplies, showers, and water closets. 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 12”x12”x4” concrete slab, flush with grade.

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

E. Install thermometers on domestic hot water piping leaving water heaters, and as indicated on the drawings.

F. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur, or as indicated on the drawings.

   1. Test backflow preventers in accordance with ASSE 5013.
   2. Pipe relief from backflow preventer air gap fitting to nearest drain.

END OF SECTION - 22 05 04
SECTION 22 05 23 - GENERAL - DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ball valves.
   2. Plug valves.
   3. Check valves.
   4. Domestic hot water balancing valves.
   5. Thermostatic Mixing Valves.

B. Related Requirements:
   1. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
   2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product and installation requirements for pipe hangers and supports.
   3. Section 22 07 00 - Plumbing Insulation: Product and installation requirements for insulation for valves.

1.2 REFERENCES

A. ASTM International:

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 67 - Butterfly Valves.
   2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
   3. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
   4. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
1.4 CLOSEOUT SUBMITTALS
   A. Project Record Documents: Record actual locations of valves.
   B. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
   B. Installer: Company specializing in performing work of this section.

1.6 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.

PART 2 - PRODUCTS

2.1 GATE VALVES
   A. Up to and Including 2 Inches:
      1. Manufacturers:
         a. Nibco Model T-111-LF
         b. Jenkins
         c. Milwaukee
         d. KITZ
   2. MSS SP-139, NSF/ANSI 372- “Lead-Free”, Class 150, bronze body, bronze trim, rising stem, screw-in bonnet, handwheel, inside screw, solid wedge disc, threaded ends.

   B. 2 1/2 inches and Larger:
      1. Manufacturers:
         a. Nibco Model F-607-RWS
         b. Jenkins
         c. Milwaukee
         d. KITZ
   2. MSS SP-70, NSF/ANSI 372- “Lead-Free”, Class 125, iron body, bronze trim, epoxy coated inside and out, outside screw and yoke, handwheel, resilient wedge, flanged ends.

2.2 BALL VALVES
   A. Up to and including 2 inches:
      1. Manufacturers:
         a. Nibco Model T-585-66-LF
b. Milwaukee #UPBA-400S

2. NSF/ANSI 61 Lead-Free, MSS SP-110, Class 150, 600 psi CWP, bronze, two piece body, stainless steel, full port, teflon seats and stuffing box ring, blow-out proof stainless steel stem, lever handle, solder or threaded ends.

2.3 GAS VALVES:

A. Indoor Application:

1. Manufacturer:
   a. Up to and including 2 inches: McDonald Figure 10552
      1) AGA Certified, 25 lb WOG, Flat/Tee head, top check, plug type, Bronze body and plug, threaded ends

B. Outdoor Application

1. Manufacturer:
   a. Up to and including 1-1/2 inches: Homestead Figure 601,
      1) AGA Certified, 200 lb WOG, wrench operated square head, lubricated plug with check, semi-steel, threaded ends
   b. 2 inches and above: Homestead Fig. 612, Resun R-1431
      1) AGA Certified, 200 lb. WOG, straightway, wrench operated, lubricated plug, rectangular port, semi-steel, flanged ends

2. Description:
   b. Faced and drilled in accordance with ANSI B16.1 125# Cast Iron Pipe Flanges and Flanged Fittings.
   c. ANSI B16.10 - Face to Face Dimensions of Ferrous Flanged End Valves; Class 125. multiple port and round port valves not covered by this specification.
   d. ASTM - A-126 Grade B - Body and Plug Material
   e. Lubricated plug type, without taper, and with close tolerance between the plug and body sealing surfaces.
   f. stem seal of reinforced Teflon.
   g. Leak-proof, spring loaded ball and lubricant sealed check valve;
   h. Combination lubricant screw and button head fitting to prevent foreign matter from being forced into lubricant system.
   i. Valve plugs floated on low-friction Teflon surfaces
   j. Port area equal to 100% of the area of standard pipe (or standard opening if desired).
   k. Constructed that lubricant system has sufficient pressure to force lubricant over all seating surfaces.
   l. Extruded Lubricant around stem is to be positive indication that lubricant system is full, and that there had been a minimum contamination of line fluids.

2.4 CHECK VALVES

A. Up to and Including 3 inches:

1. Manufacturers:
   a. Nibco Model T-433-B
   b. Milwaukee Model 1510-T.
c. Crane Model 137.
2. MSS SP-80, Class 150, bronze body and cap, bronze swing disc with renewable seat, threaded ends.

2.5 DOMESTIC HOT WATER BALANCING VALVES

A. Manufacturers:
   1. Nibco Model T/S-1810LF

B. NSF/ANSI 61 Lead-Free, ANSI B1.20.1, DZR brass body, globe style balancing valve with brass bonnet and trim, memory stops and position display window on handwheel, rated for 240 psi at 250 degrees F, with 2 P/T ports for differential pressure measurement.

2.6 THERMOSTATIC WATER MIXING VALVES – SERVING WH-1

A. Manufacturers:
   1. Armstrong Model Rada 425R.
   2. No substitutions.

B. Provide factory assembled and tested thermostatic mixing valve assembly constructed of DBZ brass with stainless steel internal operating mechanism.

C. Thermostatic mixing valve shall have hot water inlet, cold water inlet, mixed water outlet and mixed return inlet with thermostatic return limiter to maintain circuit temperature during no-demand periods. Assembly shall also include mixed return sight flow indicator, outlet thermometer and inlet supply, mixed return and return to heat source check valves.

D. Thermostatic mixing valve shall be equipped with removable temperature adjustment key with lockshield for single temperature lock out capability.

E. Thermostatic mixing valve shall have dual thermostats.

F. Valve temperature set-point shall be 110°F.

2.7 THERMOSTATIC WATER MIXING VALVE – SERVING WH-2

A. Manufacturer:
   1. Zurn model ZW1017XL.

B. Aqua-Gard Tempering Mixing Valve: ASSE 1017, lead-free design, cast bronze body ASTM B 584, polysufone piston, low lead brass internal components, nitrile elastomer seals.

2.8 GAS PRESSURE REGULATORS

A. Pressure Regulator:
   1. Manufacturers:
      a. Sizes up to 1x1: Fisher S102
      b. Sizes 1-1/4 inch and larger: Fisher S302
   2. Cast iron body, aluminum spring case and components
   3. Internal pressure relief.
   4. 6-14 in. wc outlet pressure.
5. Verify inlet pressure with actual jobsite gas service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping system is ready for valve installation.

3.2 INSTALLATION

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

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

C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible.

F. Refer to Section 22 05 29 for pipe hangers.

G. Refer to Section 22 07 00 for insulation requirements for valves.

H. Refer to Section 22 05 03 for piping materials applying to various system types.

I. Gas Pressure Regulators:

1. Size in accordance with manufacturers tables. Document inlet pressure and outlet pressure.

2. Install gas pressure regulators with gas valve immediately upstream of each regulator. Provide union immediately before and after each regulator.

3. Roof installations: Install regulator so that vent opening faces downward. Install regulator in loop above roof as required to maintain vent opening minimum of 12 inches above roof.

3.3 VALVE APPLICATIONS

A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.

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

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

D. Install swing check valves on discharge of water pumps.

E. Provide plug valves in natural gas systems for shut-off service.
SECTION 22 05 29 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Inserts.
   4. Flashing.
   5. Sleeves.
   6. Mechanical sleeve seals.
   7. Formed steel channel.
   8. Firestopping relating to plumbing work.
  10. Equipment bases and supports.

B. Related Sections:
   1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
   2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
   3. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME B31.9 - Building Services Piping.

B. ASTM International:

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.
D. FM Global:

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: UL 263 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

   1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code and UL for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

B. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
   2. Floor Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
      a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

B. Through Penetration Firestopping of Non-Fire Rated Floor Assemblies: Materials to resist free passage of flame and products of combustion.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

D. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.8 QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Carpenter & Paterson Inc.
2. Creative Systems Inc.
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.

B. Plumbing Piping - DWV:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
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 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.2 ACCESSORIES
A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

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

2.4 PIPE ROOF PENETRATION
A. Manufacturer:
   1. ChemLink ChemCurb System
B. Product:
   3. 1-Part: pourable 100% rubber sealer resistant to deterioration, melting, and shrinking.

2.5 PIPING ON ROOF
A. Manufacturer:
   1. Mapa Products MS-4, MS-5
B. Product:
   1. Fiberglass reinforced 6/6 nylon base with 3/8” stainless steel threaded rod. Solid rubber roller with adjustable height. Neoprene or rubber base pad depending on pipe size.
   2. MS-4 for pipe size less than 2-1/2”
   3. MS-5 for pipe size less than 4”
C. Installation:
1. Support steel gas piping on roof.
2. Install as per the manufacturer’s recommendations.
3. Maintain 8 inches of clearance between roof deck and pipe.
4. Spacing:
   a. Pipe 3/4 inches to 1 inch: 8 feet.
   b. 1-1/4 inch to 1-1/2 inches: 10 feet.
   c. 2 to 3 inches: 6 feet

2.6 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors:
Steel pipe or 18 gage thick galvanized steel.

2.7 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Thunderline Link-Seal, Inc.
   2. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.8 FORMED STEEL CHANNEL

A. Manufacturers:
   1. Allied Tube & Conduit Corp.
   2. B-Line Systems
   3. Midland Ross Corporation, Electrical Products Division
   4. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.9 FIRESTOPPING

A. Refer to specification sections 07 84 13 and 07 84 46.

2.10 FIRE STOP SYSTEMS

A. Refer to specification section 07 84 13.

2.11 FIRESTOPPING ACCESSORIES

A. Refer to specification sections 07 84 13 and 07 84 46 for penetrations through rated surfaces.

B. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.

2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing or damming materials to arrest liquid material leakage.

D. Do not drill or cut structural members.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1 ASME B31.5 ASME 31.9 ASTM F708 MSS SP 58 MSS SP 69 MSS SP 89.

B. Support horizontal piping as scheduled.

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

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

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

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

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 22 05 48.

3.5 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor and mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.
3.7 INSTALLATION - FIRESTOPPING

A. Refer to specification sections 07 84 13 and 07 84 46 for installation of firestopping materials through rated surfaces.

B. Non-Rated Surfaces:

1. Seal opening through non-fire rated wall, as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
   b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
   c. Install type of firestopping material recommended by manufacturer.

2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

3.8 SCHEDULES

A. Steel and Copper Pipe Hanger Spacing

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>MAX. HANGER SPACING</th>
<th>ROD DIAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Feet</td>
<td>Inches</td>
</tr>
<tr>
<td>½ to 1-1/4</td>
<td>6.0</td>
<td>1/4</td>
</tr>
<tr>
<td>1-1/2 to 2</td>
<td>10</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2 to 4</td>
<td>10</td>
<td>1/2</td>
</tr>
</tbody>
</table>

B. Cast Iron Pipe Hanger Spacing

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>MAX. HANGER SPACING</th>
<th>ROD DIAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Feet</td>
<td>Inches</td>
</tr>
<tr>
<td>2 to 3 inch</td>
<td>5</td>
<td>3/8</td>
</tr>
<tr>
<td>4 to 5 inch</td>
<td>8</td>
<td>1/2</td>
</tr>
<tr>
<td>6 to 8 inch</td>
<td>8</td>
<td>3/4</td>
</tr>
</tbody>
</table>

3.9 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION – 22 05 29
SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Labels.

B. Related Sections:

C. Section 09 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 SUBMITTALS

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

B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

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

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

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

1.4 QUALIFICATIONS

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

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

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.
PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

2. Safety Sign Co.
4. Marking Services Inc.

B. Product Description: Laminated three-layer plastic with engraved white letters on black background. Minimum 1-1/2” x 4” size with 16 point Helvetica font.

2.2 TAGS

A. Metal Tags:

1. Manufacturers:
   a. Seton Identification Products.
   b. Marking Services Inc.
2. Brass with stamped letters; tag size minimum 1-1/2 inches with smooth edges.

B. Information Tags:

1. Manufacturers:
   a. Seton Identification Products.
   b. Marking Services Inc.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

1. Outside Diameter of Insulation or Pipe Less than 3/4 inches: use tags
2. 3/4 to 1-1/4 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters, 1/8 inch wide stroke.
3. 1-1/2 to 2 inches Outside Diameter of Insulation or Pipe: 3/4 inch high letters, 3/16 inch wide stroke.
4. 2-1/2 to 4 inches Outside Diameter of Insulation or Pipe: 1-inch high letters, 5/16 inch wide stroke.
5. 6 to 10 inches Outside Diameter of Insulation or Pipe: 2-1/2 inch high letters, 5/8 inch wide stroke

2.4 TRACER WIRE

A. Product:
   1. Provide and install 16 gauge bare copper tracer wire along the entire length of buried piping beyond the building exterior wall.
   2. Wire to be one piece - no splices
   3. Install 12 inches above piping.
   4. Bring each end of wire up to grade.
   5. Termination:
      a. Sewer lines: terminate at building wall, clamp to minimum 6 foot 3/4 inch rebar set in ground adjacent to pipe entry into building. Rebar to be exposed 2 inches above ground.
      b. Gas lines: terminate at gas rise at building wall. Clamp wire to riser pipe.

2.5 PIPE IDENTIFICATION COLORS:

A. Cover exposed insulated piping along entire exposed length with white PVC jacket. Refer to Section 22 07 00.

PART 3 - EXECUTION

3.1 PREPARATION

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

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

3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 09.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

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

G. Identify water heaters, pumps, tanks with plastic nameplates.

H. Identify in-line pumps and other small devices with tags.

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

J. Identify piping, concealed or exposed, with stenciled painting. 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.

END OF SECTION – 22 05 53
SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing piping insulation, jackets and accessories.
   2. Plumbing equipment insulation, jackets and accessories.

1.2 REFERENCES

A. ASTM International:
   4. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
   7. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

1.3 SUBMITTALS

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

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
1.4 QUALITY ASSURANCE
   A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed
      index of not exceeding 50 in accordance with ASTM E84.
   B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
   C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1.5 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with
      minimum three years documented experience.
   B. Applicator: Company specializing in performing Work of this section with minimum three
      years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Accept materials on site in original factory packaging, labeled with manufacturer’s
      identification, including product density and thickness.
   B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by
      storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS
   A. Install insulation only when ambient temperature and humidity conditions are within range
      recommended by manufacturer.
   B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.8 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURER
   A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
      1. CertainTeed.
      2. Knauf.
      4. Owens-Corning.

2.2 PIPE INSULATION
   A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
   1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, color as indicated.
   2. Thickness: 15 mil.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive:
   1. Childers CP-82
   2. Fosters 85-20
   3. Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Shields:
   1. Galvanized steel insulation protection shield
   2. MSS SP-69, Type 40.
   3. Length: Based on pipe size and insulation thickness.

D. Inserts:
   1. HamFab 20 lb. density H-Blocks
   2. Length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

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

F. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

G. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

H. Adhesives: Compatible with insulation.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping has been tested before applying insulation materials.
B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Install in accordance with NAIMA National Insulation Standards.
B. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
C. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 22 05 29 for penetrations of assemblies with fire resistance rating.
D. Piping Systems Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
   2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
   3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
   4. Install PVC fitting covers and vapor barrier adhesive.
E. Hot Piping Systems:
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
   3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.
   4. Install PVC fitting covers and vapor barrier adhesive.
F. Non-Potable distribution piping shall not be insulated.
G. Inserts and Shields:
   1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
   2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Insulation Terminating Points:

1. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces:

1. Finish with white PVC jacket and fitting covers.

3.3 SCHEDULES

A. Domestic Hot Water Supply - 140 deg F and lower:

1. Type: P-1
2. Insulation Thickness:
   a. Pipe Size Range: 1-1/4 inches and less
      1) Thickness: 1 inch
   b. Pipe Size Range: 1-1/2 inches and larger
      1) Thickness: 1-1/2 inches

B. Domestic Hot Water Recirculation - 140 deg F and lower:

1. Type: P-1
2. Insulation Thickness:
   a. Pipe Size Range: 1-1/4 inches and less
      1) Thickness: 1 inch
   b. Pipe Size Range: 1-1/2 inches and larger
      1) Thickness: 1-1/2 inches

C. Domestic Cold Water:

1. Type: P-1
2. Insulation Thickness:
   a. Pipe Size Range: all sizes
      1) Thickness: 1/2 inch
D. Roof Drain Bodies:
   1. Type: P-1
      a. Pipe Size Range: All sizes.
         1) Thickness: 1 inch.

E. Roof Drainage Run Horizontal at Roof Level:
   1. Type: P-1
      a. Pipe Size Range: All sizes.
         1) Thickness: 1 inch.

F. Equipment Drains (Condensate Drains):
   1. Type: P-1
   2. Insulation Thickness:
      a. Pipe Size Range: all sizes.
         1) Thickness: 1/2 inch

END OF SECTION – 22 07 00
SECTION 22 14 29 - PLUMPING PUMPS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. In-line circulator pumps.
   B. Related Sections:
      1. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment.
      2. Section 22 05 23 - General-Duty Valves for Plumbing Piping.

1.2 DESIGN REQUIREMENTS
   A. Design Criteria:
      1. Refer to schedule on drawings.

1.3 SUBMITTALS
   A. Section 22 00 00 - Submittal Procedures: Requirements for submittals.
   B. Shop Drawings:
      1. Submit installation details for pumps, piping, controls and accessories including wiring schematics.
   C. Product Data: Submit data for specified Products.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

1.5 QUALIFICATIONS
   A. Manufacturer: company specializing in manufacturing Products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing work of this section.
1.6 DELIVERY, STORAGE AND HANDLING

A. Prepare pumps and accessories for shipment to prevent entry of foreign matter into product body.

B. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

PART 2 - PRODUCTS

2.1 SYSTEM LUBRICATED CIRCULATORS

A. Manufacturers:
   1. Grundfos
   2. Bell and Gossett

B. Type:
   1. Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psig maximum working pressure, 230 degrees F maximum water temperature.

C. Casing: Bronze with flanged pump connections.

D. Impeller, Shaft, Rotor, bearing plate: Stainless Steel.

E. Bearings: Tungsten Carbide.

F. Motor: Impedance protected, multiple three speed.

G. Performance: As scheduled on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify connections, size, and location are as indicated on Drawings.

3.2 INSTALLATION
A. Provide necessary piping, fittings, and valves as indicated on Drawings.

B. Provide pumps to 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.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation, examine, adjust and test each pump for proper operation.

B. Test each pump with clean water through minimum of four complete cycles.

END OF SECTION – 22 14 29
SECTION 22 36 00 - DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fuel-Fired domestic water heaters.
   2. Domestic hot water expansion tanks.

B. Related Sections:
   1. Section 03 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME PTC 25 - Pressure Relief Devices.
   2. ASME Boiler and Pressure vessel code, section IV, Part HLW
   3. ANSI Z2.110.3/CSA 4.3 “Gas Water Heaters”
   4. ASHRAE/IES 90.1
   5. NFPA 70 – National Electric Code
   7. NSF/ANSI Standard 61 – Drinking Water System Components
   8. NSF/ANSI Standard 372 – Drinking Water System Components – Lead Content
   9. NSF 5 – Water heaters, Hot water supply boilers and heat recovery equipment

1.3 SUBMITTALS

A. Section 22 00 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions, anchors, attachments, lifting points, taps, and drains.

C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit replacement part numbers and availability.
1.5 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect heat exchangers and tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

1.8 WARRANTY
A. Fuel-Fired Domestic Water Heaters:
   1. Heat Exchanger Assembly and Leaks: 3 year.
   2. Burner and all heater parts: 1 year.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS FIRED WATER HEATERS
A. Manufacturer:
   1. PVI, No Exceptions.
B. Construction:
   1. Furnish and install fuel-fired domestic water heater with input and storage capacity as shown on the plans.
   2. The water heater will be a vertical fire tube, design that is constructed and stamped in accordance with Section IV, Part HLW of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure.
   3. Water heater will be a single-pass, down-fired, fire tube design contained within an integral storage tank.
   4. Tank, combustion chamber and fire tubes will be unlined. Lined or plated water heaters will not be acceptable.
   5. Tank, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride.

6. Tank will be welded utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

7. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.

8. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.

9. All water contacting tank surfaces will be non-porous and exhibit 0% water absorption.

10. All tank connections/fittings will be non-ferrous or stainless steel.

11. To preserve thermal efficiency, the water heater will not use or require a circulator piped from the hot water outlet to the cold water inlet of the heater for the purpose of temperature control during normal operation. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping. Connection to a sidearm tank, if used, will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.

12. Finished vessel will not require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will not be acceptable.

13. Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified.

14. Burner will be stainless steel.

15. Gas train components will capable of self-proportionating gas and air to maintain optimum combustion in response to varying vent pressures.

16. At 199,000 to 399,000 BTU input, the burner will be fixed input.

17. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.

C. Performance:

1. Water heaters shall operate at a minimum 95.3% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).

2. Water heater will meet the thermal efficiency and standby heat loss requirements of the latest version of the ASHRAE 90.1 standard.

3. Water heater will be certified by the DOE/EPA Energy Star program for commercial water heaters, whereby standby loss and thermal efficiency are independently tested and certified.

4. Water heater will be third party tested and certified to NSF 5.

5. Water heaters will be third party tested and certified to NSF/ANSI 372 standard for lead content.

D. Water Heater Trim:

1. As a minimum, the heater will be equipped with the following:
   a. Electronic flame monitoring
b. Electronic low water cutoff
c. An immersion operating control
d. An immersion UL listed temperature limiting device
e. An ASME-rated temperature and pressure relief valve

2. Operating and safety controls shall meet the requirements of UL 795 and FM
3. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol.

E. Accessories:
   1. Provide water heaters with condensate neutralization system.
   2. Provide water heaters with pigtail kit for 120V plug-in power cord.
   3. Provide water heaters with concentric vent kit.

F. Start-up:
   1. Water heaters shall be started up by factory authorized technician.

2.2 ELECTRIC DOMESTIC WATER HEATERS

A. Manufacturer:
   1. AO Smith
   2. State
   3. Lochinvar

B. Type: Automatic, electric, vertical storage.

C. Performance:
   1. Refer to schedule on drawings

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 110 to 170 degrees F, flanged or screw-in nichrome elements, enclosed controls and electrical junction box. Wire double element units so elements do not operate simultaneously.
   1. Accessories: Brass water connections and dip tube, drain valve, magnesium anode, and ASME temperature and pressure relief valve.

2.3 DOMESTIC HOT WATER EXPANSION TANKS

A. Manufacturer:
   1. State
   2. Amtrol
   3. AO Smith

B. IAPMO certified, welded steel construction with butyl rubber diaphragm, suitable for potable water installation, 150 psig maximum working pressure, 3/4 inch MPT connection

C. 5 year warranty.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water heaters in accordance with manufacturer's instructions and to AGA, NSF, NFPA 54, UL requirements.

B. Coordinate with plumbing piping and related fuel piping, gas venting and electrical work to achieve operating system.

C. Maintain manufacturer's recommended clearances around and over water heaters.

D. Install water heater on concrete housekeeping pad, minimum 4 inches high and 6 inches larger than water heater base on each side.

E. Connect domestic hot water, domestic cold water and steam piping to water heater connections.

F. Pipe relief valves and drains to nearest floor drain.

G. Install water heater trim and accessories furnished loose for field mounting.

H. Support expansion tanks individually – do not support from piping.

I. Domestic Water Heaters:
   1. Support vent and intake piping independently of water heater.
   2. Extend discharge from T&P valve to floor drain.
   3. Connect gas piping to water heaters with gas cock, dirt leg and union. Make final connection with flexible gas piping.
   4. Install isolation valves on inlet and discharge of water heater. Provide unions at connection to water heater. Provide heat trap in water connections on systems which are not circulated.
   5. Install expansion tanks on system with circulators. Install expansion tanks between cold water inlet check valve and heater.
   6. Coordinate with plumbing piping and related fuel piping, gas venting and electrical work to achieve operating system.

3.2 CLEANING

1. Clean all construction debris and dust from equipment rooms. Leave equipment clean. Blow out all construction dust from all internal portions of equipment, control cabinets, pump motors, and burners.

END OF SECTION – 22 36 00
SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Urinals.
   3. Lavatories.
   4. Washfountains.
   5. Sinks.
   6. Drinking fountains.
   7. Service sinks.

B. Related Sections:
   1. Section 22 11 00 - Facility Water Distribution: Supply connections to plumbing fixtures.
   2. Section 22 13 00 - Facility Sanitary Sewerage: Waste connections to plumbing fixtures.

1.2 REFERENCES

A. American National Standards Institute:

B. American Society of Mechanical Engineers:
   1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
   2. ASME A112.18.1 - Plumbing Fixture Fittings.
   3. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
   4. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   5. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.3 SUBMITTALS

A. Section 22 00 00 - Submittal Procedures.

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

C. Manufacturer's Installation Instructions: Submit installation methods and procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALITY ASSURANCE
   A. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

1.6 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Accept fixtures on site in factory packaging. Inspect for damage.
   B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY
   A. Provide two year manufacturer warranty for electric water cooler.

PART 2 - PRODUCTS

2.1 WHEEL HANDLE ¼ TURN STOPS
   A. Manufacturers:
      1. Brass Craft model KTR13 FC
      2. No substitutions.
   B. Operating Temperature:
      1. 40-150 degrees F. Intermittent to 180 degrees F.
   C. Operating Pressure:
      1. 125 psi maximum.
D. Material Specifications:
   1. Body and brass components: Chrome plated C36000 brass.
   2. Stem: Plated C36000 brass.
   3. Seats: Pure PTFE.
   4. Ball: Chrome plated C36000 brass.
   5. O-Ring: Nitrile.
   6. Handle: Chrome plated zinc die cast.
   8. 1/2 inch straight female iron pipe threaded inlet

2.2 FLEXIBLE SUPPLY RISERS

A. Manufacturers:
   1. Brass Craft Speedi Plumb Plus

B. Operating Temperature:
   1. 40-150 degrees F. Intermittent to 180 degrees F.

C. Operating Pressure:
   1. 125 psi maximum.

D. Material Specifications:
   1. Nuts: C36000 brass.
   2. End fittings: C36000 brass.
   4. Tubing: EPDM rubber.
   5. Washers: Nitrile rubber.

2.3 CHROME PLATED BRASS P-TRAP

A. Manufacturers:
   1. Brass Craft
   2. McGuire
   3. Dearborn Brass

B. Chrome-plated 17-gauge brass tubing p-trap with clean-out. Provide with brass quarter bend, brass clean-out plug, fiber clean-out washer, rubber washers, die cast nuts.

C. Size:
   1. Lavatory: 1-1/4 inch x 1-1/4 inch.
   2. Sink: 1-1/2 inch x 1-1/2 inch.
2.4 OFFSET WASTE WITH PERFORATED OPEN STRAINER

A. Manufacturers:
   1. Brass Craft part number 0702.
   2. McGuire part number 155WC.

B. Polished chrome cast brass offset lavatory strainer, ADA compliant, cast brass solid top open
   grid strainer, cast brass elbow and 1-1/4 inch 17 gauge offset tailpiece.

2.5 P-1 – WATER CLOSET, FLOOR MOUNT, SENSOR OPERATED FLUSH VALVE –
   ADULT TAS

A. Bowl:
   1. Manufacturers:
      a. American Standard Model 3043.001
      b. Kohler
   2. ASME A112.19.2M; floor mounted, siphon jet 16-1/2 inch bowl height, TAS accessible,
      vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud, china bolt caps,
      minimum 2 inch passageway.

B. Sensor Operated Flush Valve:
   1. Manufacturer:
      a. Sloan Regal 111 SMO-1.28-OR
      b. No Exceptions
   2. ASME A112.19.2; exposed chrome plated, diaphragm type with battery operated
      solenoid operator, infrared sensor and over-ride button in chrome plated plate, integral
      screwdriver stop and vacuum breaker, adjustable tailpiece, vandal resistant stop cap with
      set screw, sweat solder adapter with cover tube and cast set screw wall flange, maximum
      1.28 gallon flush volume, 11-1/2 inch riser.

C. Seat:
   1. Manufacturer:
      a. Bemis Model 1955 SSC
      b. Beneke 523 SS
   2. Solid white plastic, open front, extended back, self-sustaining hinge, and brass bolts.

2.6 P-2 – WATER CLOSET, FLOOR MOUNT, FLUSH VALVE – CHILD TAS (AGES 9-12)

A. Bowl:
   1. Manufacturers:
      a. American Standard Model 2599.001
      b. Kohler.
2. ASME A112.19.2M; floor mounted, siphon jet 14 inch bowl height, Child TAS accessible, vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud, china bolt caps, minimum 2 inch passageway.

B. Sensor Operated Flush Valve:

1. Manufacturer:
   a. Sloan Regal 111 SMO-1.28-OR
   b. No Exceptions
2. ASME A112.19.2; exposed chrome plated, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, integral screwdriver stop and vacuum breaker, adjustable tailpiece, vandal resistant stop cap with set screw, sweat solder adapter with cover tube and cast set screw wall flange, maximum 1.28 gallon flush volume, 11-1/2 inch riser.

C. Seat:

1. Manufacturer:
   a. Bemis Model 1955 SSC
   b. Beneke 523 SS
2. Solid white plastic, open front, extended back, self-sustaining hinge, and brass bolts.

2.7 P-3 – WATER CLOSET, FLOOR MOUNT, FLUSH VALVE – CHILD

A. Bowl:

1. Manufacturers:
   a. American Standard Model 2599.001
   b. Kohler.
2. ASME A112.19.2M; floor mounted, siphon jet 14 inch bowl height, Child TAS accessible, vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud, china bolt caps, minimum 2 inch passageway.

B. Sensor Operated Flush Valve:

1. Manufacturer:
   a. Sloan Regal 111 SMO-1.28-OR
   b. No Exceptions
2. ASME A112.19.2; exposed chrome plated, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, integral screwdriver stop and vacuum breaker, adjustable tailpiece, vandal resistant stop cap with set screw, sweat solder adapter with cover tube and cast set screw wall flange, maximum 1.28 gallon flush volume, 11-1/2 inch riser.

C. Seat:

1. Manufacturer:
   a. Bemis Model 1955 SSC
   b. Beneke 523 SS
2. Solid white plastic, open front, extended back, self-sustaining hinge, and brass bolts.
2.8  **P-4 – WALL HUNG URINALS – CHILD TAS (AGES 9-12)**

A. Urinal:

1. Manufacturers:
   a. American Standard 6590.001
   b. Kohler
2. ASME A112.19.2; vitreous china, wall hung washout action urinal with shields, 14 inch extended lip, integral trap, 3/4 inch top spud.
3. 0.5 gallons per flush maximum.
4. Refer to architectural elevations for mounting height.

B. Sensor Operated Flush Valve:

1. Manufacturer:
   a. Sloan Regal 186 SMO-0.5-OR
   b. No Exceptions
2. ASME A112.19.2; exposed chrome plated, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, integral screwdriver stop and vacuum breaker, adjustable tailpiece, vandal resistant stop cap with set screw, sweat solder adapter with cover tube and cast set screw wall flange, maximum 0.5 gallon flush volume, 11-1/2 inch riser.

C. Wall Mounted Carrier:

1. Manufacturers:
   a. Wade W-400
   b. Zurn Z-1221
2. ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger.

2.9  **P-5 – WALL HUNG URINALS – CHILD**

A. Urinal:

1. Manufacturers:
   a. American Standard 6590.001
   b. Kohler
2. ASME A112.19.2; vitreous china, wall hung washout action urinal with shields, 14 inch extended lip, integral trap, 3/4 inch top spud.
3. 0.5 gallons per flush maximum.
4. Refer to architectural elevations for mounting height.

B. Sensor Operated Flush Valve:

1. Manufacturer:
   a. Sloan Regal 186 SMO-0.5-OR
   b. No Exceptions
2. ASME A112.19.2; exposed chrome plated, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, integral
screwdriver stop and vacuum breaker, adjustable tailpiece, vandal resistant stop cap with set screw, sweat solder adapter with cover tube and cast set screw wall flange, maximum 0.5 gallon flush volume, 11-1/2 inch riser.

C. Wall Mounted Carrier:

1. Manufacturers:
   a. Wade W-400.
   b. Zurn Z-1221

2. ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger.

2.10 P-6 – LAVATORY, WALL MOUNTED – ADULT TAS

A. Vitreous China Wall Hung Basin:

1. Manufacturers:
   a. American Standard 0124.131
   b. Kohler

2. ASME A112.19.2; vitreous china wall hung lavatory 19-1/4 inch x 17-1/4 inch, Ledge-back, 4 inch centers, rectangular basin with splash lip, rear overflow, and soap depression.

3. Refer to Architectural Interior Elevations for fixture installation height.

B. Supply Fitting:

1. Manufacturers:
   a. American Standard model 7385.004
   b. Elkay

2. ASME A112.18.1; single lever handle, chrome plated sensor faucet, 0.5 gpm vandal resistant aerator, 4” centers, ceramic cartridges.

C. 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. Wheel handle ¼ turn stops.
4. Flexible supplies.
5. True-Bro handicap insulation kit.

D. Wall Mounted Carrier:

1. Manufacturer: Wade W-520

2. ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs.

2.11 P-7 – LAVATORY, WALL MOUNTED – CHILD TAS (AGES 9-12)
A. Vitreous China Wall Hung Basin:

1. Manufacturers:
   a. American Standard 0124.131
   b. Kohler
2. ASME A112.19.2; vitreous china wall hung lavatory 19-1/4 inch x 17-1/4 inch, Ledge-back, 4 inch centers, rectangular basin with splash lip, rear overflow, and soap depression.
3. Refer to Architectural Interior Elevations for fixture installation height.

B. Supply Fitting:

1. Manufacturers:
   a. American Standard model 7385.004
   b. Elkay
2. ASME A112.18.1; single lever handle, chrome plated sensor faucet, 0.5 gpm vandal resistant aerator, 4” centers, ceramic cartridges.

C. 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. Wheel handle ¼ turn stops.
4. Flexible supplies.
5. True-Bro handicap insulation kit.

D. Wall Mounted Carrier:

1. Manufacturer: Wade W-520
2. ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs.

2.12 P-8 – WALL HUNG LAVATORY SYSTEM, 3 STATION – CHILD TAS (AGES 9-12)

A. Unit:

1. Sloan model ELS-63000
   a. No Substitutions
2. Multiple lavatory system with three hand washing stations
3. Each station complies with Texas Accessibility Standards.

B. Bowl:

1. Molded SloanStone solid surface with deck mounted Sloan integrated automated sensor faucets.
2. Three definitive stations.
3. Refer to Architectural elevations for installation heights.
4. Color as selected by the Architect.
2.13 P-9 – CLASSROOM HAND SINK WITH BUBBLER – CHILD TAS (AGES 9-12)

A. Single Compartment Bowl:
   1. Manufacturer: Elkay DRKAD-3119-35
   2. ASME A112.19.3; 31 x 19 x 3-1/2 inch deep outside dimensions, 18 gage thick, Type 302 stainless steel, self-rimming and undercoated, ledge back.
   3. Drilling for faucet shall be on left side and in center of sink.
   4. Drilling for bubbler shall be on right side and 2 inch from front edge of sink.

B. Supply:
   1. Manufacturer: Moen model 8103, No Exceptions.
   2. ASME A112.18.1; single handle top mount gooseneck faucet, rigid spout with aerator, brass base with lever handle on left side, for single hole installation.

C. Bubbler:
   1. Manufacturer: Elkay LK1141A.
   2. Push-button valve bubbler. Heavy chrome plated body with ½” straight pipe thread connection.
   3. Mouth guard shall be pliable polyester elastomer.

D. Strainer:
   1. Manufacturer: Elkay LK-35L strainer with elbow for offset drain, with stainless steel conical strainer.

E. Accessories:
   1. Chrome plated offset tailpiece with 17 gage brass p-trap with cleanout plug, escutcheon, wheel handle brass stops and flexible chrome risers.

2.14 P-10 – SINGLE COMPARTMENT STAINLESS STEEL SINK – ADULT TAS

A. Single Compartment Sink:
1. Manufacturers:
   a. Elkay Model LRAD221955
   b. Just
2. ASME A112.19.3; 22x19x5.5 inch outside dimensions, 18 gage thick, Type 304 stainless steel, counter mount and undercoated, with 3-1/2 inch crumb cup and tailpiece, drain in center rear, back drilled for three hole trim.

B. Supply Fitting:
   1. Manufacturer:
      a. T&S Brass model B2862
      b. Chicago Faucets
   2. ANSI/ASME A112.18.1, 8-13/16” high rise gooseneck, 8” widespread centers, spout to swing 120 degrees, wristblade handles, ceramic cartridges, ADA compliant, water economy aerator with maximum 2.2 gpm flow.

C. Waste Fittings: ASME A112.18.2 or ASTM F 409.

D. Accessories:
   1. Chrome plated 17 gage brass P-trap.
   2. Offset waste with perforated open grid strainer.
   3. Wheel handle stops.
   4. Flexible supplies.
   5. True-Bro Insulation kit.

2.15 \textbf{P-11 – SINGLE COMPARTMENT STAINLESS STEEL SINK}

A. Single Compartment Sink:
   1. Manufacturers:
      a. Elkay Model LRAD221965
      b. Just
   2. ASME A112.19.3; 22x19x6.5 inch outside dimensions, 18 gage thick, Type 304 stainless steel, counter mount and undercoated, with 3-1/2 inch crumb cup and tailpiece, drain in center rear, back drilled for three hole trim.

B. Supply Fitting:
   1. Manufacturer:
      a. T&S Brass model B2862
      b. Chicago Faucets
   2. ANSI/ASME A112.18.1, 8-13/16” high rise gooseneck, 8” widespread centers, spout to swing 120 degrees, wristblade handles, ceramic cartridges, ADA compliant, water economy aerator with maximum 2.2 gpm flow.

C. Waste Fittings: ASME A112.18.2 or ASTM F 409.

D. Accessories:
1. Chrome plated 17 gage brass P-trap.
2. Offset waste with perforated open grid strainer.
3. Wheel handle stops.
4. Flexible supplies.
5. True-Bro Insulation kit.

2.16 P-12 – SINGLE STATION BOTTLE FILL, REFRIGERATED – CHILD TAS (AGES 9-12)

A. Fountain:

1. Manufacturer: Elkay LZWS8PK
2. NSF/ANSI 42, 53, 61, AND 372; recess mounted single height electric bottle filling station with stainless steel cover, hands-free operation, refrigerated with integral air cooled condenser.
   a. Include an electronic sensor for no-touch activation with an automatic 20 second shutoff timer.
   b. Include bottler counter.
   c. Provide 1 gpm flow rate with laminar flow to minimize splashing.
   d. Include antimicrobial protected plastic components to prevent mold and mildew.
3. Capacity: 8 gph of 50 degree F water with inlet at 80 degree F and room temperature of 90 degree F.
4. Electrical: Maximum 370 watt compressor, cord and plug for connection to electric wiring system including grounding connector.
5. TAS Compliance:
   a. Refer to architectural elevations for installation height.

2.17 P-13 – DUAL HEIGHT ELECTRIC WATER COOLER W/ BOTTLE FILLING STATION – TAS

A. Fountain:

1. Manufacturer: Elkay EZSTL8WSLK
2. ARI 1010; surface mounted dual height electric water cooler with stainless steel top, vinyl on steel body, elevated anti-squirt flexible bubbler with stream guard, automatic stream regulator, push button, mounting bracket, refrigerated with integral air cooled condenser.
3. Bottle Filling Unit:
   a. Installed on the upper level unit.
   b. Include an electronic sensor for no-touch activation with an automatic 20 second shutoff timer.
   c. Include bottler counter.
   d. Provide 1 gpm flow rate with laminar flow to minimize splashing.
   e. Include antimicrobial protected plastic components to prevent mold and mildew.
4. Provide apron on upper unit for cane detection.
5. Capacity: 8 gph of 50 degree F water with inlet at 80 degree F and room temperature of 90 degree F.
6. Electrical: Maximum 410 watt compressor, cord and plug for connection to electric wiring system including grounding connector.
7. TAS Compliance:
a. Refer to architectural elevations for installation height.

2.18 P-14 – MOP BASIN

A. Bowl:
   1. Fiat Model TSBC 1611; 32x32x12 corner terrazzo, 6" drop front.
   2. 2 inch wide shoulders, stainless steel threshold, 3" stainless steel cast integral drain body, stainless steel strainer.

B. Trim:
   1. Manufacturers:
      a. T & S Brass Model B-0665-BSTR.
      b. Chicago.
   2. ASME A112.18.1 exposed wall type supply with lever handles, spout wall brace, pail hook, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral loose key stops and adjustable threaded wall flanges.

C. Accessories:
   1. 5 feet of 1/2 inch diameter plain end reinforced rubber hose.
   2. Hose clamp hanger.
   3. Mop hanger.

PART 3 EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

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

B. Verify rough-in heights before installation. Secure ruling on height of TAS fixtures before rough-in.

3.3 INSTALLATION

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

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

C. Install components level and plumb.
D. Install and secure fixtures in place with wall supports, wall carriers, and bolts.

E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.

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

G. For TAS accessible water closets, install flush valve with handle to wide side of stall.

3.4 INTERFACE WITH OTHER PRODUCTS

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

3.5 TAS COMPLIANCE

A. Obtain ruling on mounting heights of all fixtures.

B. Install pre-formed insulating covers on all exposed tailpieces, traps, and water service beneath TAS compliant sinks, lavatories, etc.

3.6 ADJUSTING

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

3.7 CLEANING

A. Clean plumbing fixtures and equipment.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not permit use of fixtures before final acceptance.

END OF SECTION - 22 40 00
SECTION 23 00 00 – BASIC REQUIREMENTS FOR MECHANICAL

PART 1 - GENERAL

1.1 SPECIAL NOTE

A. The Architectural, Structural, Plumbing, and Electrical Plans and Specifications, including the supplements issued thereto, Information to Bidders, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying mechanical plans. All the above is included herewith, will be issued separately or is on file at the Architect's office, for examination by all bidders. Omission of drawings will not relieve the Contractor of responsibility or be used as a basis for additional compensation.

1.2 CHECKING DOCUMENTS

A. The drawings and the specifications are numbered consecutively. Check all drawings and specifications thoroughly and notify the Engineer of any discrepancies or omissions of sheets or pages. Upon notification, the Architect or Engineer will provide the Contractor with any missing portions of the drawings or specifications.

1.3 LAWS, CODES AND ORDINANCES

A. Performance all work in accordance with the codes listed below as well as the codes of any other legal body having jurisdiction, as interpreted by the inspecting authority.

1. 2015 International Building Code (IBC)
2. 2015 International Mechanical Code (IMC)
3. 2015 International Plumbing Code (IPC)
4. 2015 International Energy Conservation Code (IECC)
5. 2015 International Fire Code (IFC)
6. Americans with Disabilities Act (ADA)
7. Texas Accessibility Standards (TAS)
8. US Department of Labor
   a. Occupational Safety and Health Administration's (OSHA) Occupational Safety and Health Standards.
9. National Fire Protection Association (NFPA)
   b. NFPA 14, Installation of Standpipe and Hose Systems.
   c. NFPA 24, Installation of Fire Service Mains and Their Appurtenances.

B. Where these specifications and the accompanying drawings conflict with these requirements, report the matter to the Engineer for clarification.
1.4 AMERICANS WITH DISABILITIES ACT (ADA) / TEXAS ACCESSIBILITY STANDARDS (TAS)

A. Install all work to conform with the requirements of the Americans with Disabilities Act (ADA) and the Texas Accessibility Standards (TAS). Where conflicts occur between these two standards, the TAS shall govern.

B. Obtain documentation referencing these standards, and install work in strict accordance with them. Before installing any work where it is unclear as to the exact requirements of the standards, obtain a ruling from the Architect or Engineer for an interpretation of the requirements.

C. The following is a general outline of requirements for mechanical and plumbing items. These items are for general reference only. Consult the original standard for exact requirements. These items include but are not limited to the following:

1. Thermostats and other controls:
   a. Maximum mounting height to the top of the device is 48 inches.

1.5 GENERAL

A. In general, the lines and ducts to be installed by the various trades under these specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of various lines and ducts and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. All piping and ductwork for the mechanical trade shall be concealed in chases in finished areas, except as indicated on the drawings. Horizontal lines run in areas that have ceilings shall be run concealed in those ceilings, unless otherwise specifically indicated or directed.

C. Piping and ductwork may be run exposed in machinery and equipment spaces, where serving as connections to motors and equipment items in finished rooms where exposed connections are required, and elsewhere as indicated on the drawings or required.

D. All conduits in any space where they are exposed shall run parallel with the building walls. They shall enter the concealed areas perpendicular with the walls, ceilings or floors. Fittings shall be used where necessary to comply with this requirement.

E. The mechanical plans do not give exact details as to elevations of lines and ducts, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other installation details. Carefully lay out work at the site to conform to the architectural and structural conditions, to provide proper grading of lines, to avoid all obstruction, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

F. The mechanical plans do not give exact locations of outlets, fixtures, equipment items, etc. Determine the exact location of each item by reference to the general plans and to all detail
drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections.

G. The Contractor is responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Engineer. The Contractor shall make such necessary changes at his own expense.

H. Order of precedence shall be observed in laying out the pipe, ductwork, and material in order to fit the material into the space above the ceiling and in the chases and walls. The following order shall govern:

I. Lines requiring grade to function such as sewers.

J. Large ducts and pipes with critical clearances.

K. Conduit, water lines, and other lines whose routing is not critical and whose function would not be impaired by bends and offsets.

L. Items affecting the visual appearance of the inside of the building such as diffusers, grilles, etc. Coordinate all items to avoid conflicts at the site.

M. The Contractor understands that the work described herein and shown on the accompanying drawings results in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

N. Examine the plans and specifications for the General Construction. If these documents show any item requiring work under Division 15 and that work is not indicated on the respective "M" or "P" drawings, notify the Engineer in sufficient time to clarify before bidding.

1.6 DIMENSIONS

A. Before ordering any material or doing any work, verify all dimensions, including elevations, and be responsible for the correctness of the same. Submit any difference found to the Engineer for consideration before proceeding with the work.

1.7 INSPECTION OF SITE

A. The accompanying plans do not indicate completely the existing mechanical installations. Inspect the existing installations and be thoroughly acquainted with conditions to be met and the work to be accomplished in removing and modifying the existing work, and in installing the new work in the present building and underground serving to and from that structure.

1.8 ELECTRIC CONTROL WIRING OF HVAC MOTORS AND MOTOR-OPERATED EQUIPMENT

A. Control wiring of HVAC motors and motor-operated equipment:

B. General requirements:
1. It is the intent of these specifications to provide a clear delineation of responsibilities for the providing of electrical control wiring.
2. Coordinate divisions 23 and 26 with each other to insure that all control wiring is provided as described.
3. Furnish all required items under the contract, with responsibilities of specific items as described hereafter, or in Division 16 Specifications.
4. While these specifications indicate the contract responsibilities of the various Divisions, they do not prevent job-site mutually agreed upon revisions or modifications to these responsibilities provided that ultimate contract responsibilities are retained as described in the Specifications.

C. Responsibilities of Division 15 (Mechanical):

1. Furnish and set in place, ready for electrical connection, all HVAC motors and motor-operated HVAC equipment unless specifically noted otherwise.
2. Provide and set in place all HVAC control devices, such as relays, thermostats, electrically operated valves and related items.
3. Provide and install all HVAC and energy management system control wiring.

D. Responsibilities of Division 16 (Electrical):

1. Furnish, mount and connect to safety and disconnect switches for fan-coil units, fans and similar HVAC equipment not furnished from the factory with integral safety or disconnect switches.
2. Connect to speed switches factory furnished on fractional horsepower fan-coil units and similar equipment. Division 16 is not required to provide field installed speed switches unless specifically noted on the Drawings.
3. Furnish, mount and connect to single and two speed full voltage non-reversing motor starters for all mechanical equipment requiring starters such as fans and similar equipment unless specifically noted otherwise on the Drawings. Generally, it is the responsibility of Division 16 (electrical) to provide and install all standard magnetic starters, except for integral starters normally provided with mechanical equipment such as rooftop units.
4. Refer to the Drawings for specific or unusual connection arrangements.

1.9 MANUFACTURER’S DIRECTIONS

A. All manufactured articles shall be applied, installed and handled as recommended by the manufacturer.

1.10 MANUFACTURER’S DIRECTIONS

A. All materials are new unless otherwise specified and of the quality specified. All materials of a type for which the Underwriters Laboratories, Inc. have established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Wherever the make of material or apparatus required is not definitely specified, submit a sample to the Engineer before proceeding.
The Engineer reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Engineer's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection.

1.11 SUBSTITUTION OF MATERIALS

A. Where a definite material of a specific manufacturer is mentioned in these specifications, it has been done in order to establish a standard of quality of the product or item to be used on the project.

B. It is recognized that acceptable materials are offered by manufacturers other than those named in the specifications. All request for substitution of materials, products and equipment shall be made in writing to the Engineer at least five working days prior to the bid date. Requests made after that time or not made in writing will not be considered.

1. Furnish complete descriptive literature and complete operation and performance data on all substitute materials.
2. Include in the information a complete list of deviations of the requested item from the specified item.
3. The Engineer will investigate such requests for substitutions, and issue any acceptance of substitution by addendum.
4. Substitutions which are requested and which are allowed will be made known by the Engineer in addendum form prior to bid.
5. Approval to substitute an item does not constitute acceptance of the product to be used on the project or the omission of the submittal process.

1.12 SUBMITTAL PROCEDURES

A. NOTE: Submittals not in compliance with the following requirements will be summarily rejected.

B. The Engineer reserves the right to directly charge the Contractor for time and material costs, at standard hourly rates, if more than two (2) submittals of the same class, type of materials, or equipment is required to obtain approval.

C. Schedule submittals to expedite the Project, and deliver to Architect/Engineer. Coordinate submission of related items.

D. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.

E. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.

F. When revised for resubmission, identify all changes made since previous submission.

G. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
H. Submittal Format:

1. Submit all shop drawings at one time.
2. The contractor may submit hard copies of submittals or electronic files as directed by the architect. In either case, the contractor shall be responsible for providing the owner with a complete and corrected submittal at the end of the contract incorporating any and all review comments.
3. Hard Copies of Submittals:
   a. Bind in a three-ring binder with each section indexed according to the specifications and separate from other sections.
4. Electronic Submittals:
   a. Submit on a single CD or USB Flash Drive.
   b. All files shall be compiled into a single pdf portfolio with each section indexed according to the specifications.
      1) Individual files will NOT be accepted, and the entire submittal will be summarily rejected.
5. Identify Project, Architect, Engineer, Contractor, subcontractor and supplier.
6. Index each section according to the specifications and separate from other sections.
7. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
8. Provide a 2 inch x 5 inch space for the Engineer's review stamp on hard copies of submittals.

I. Product Data

1. Product data to be job specific.
   a. Catalogue cut sheets providing only generic information will not be accepted
   b. Equipment selections shall indicate actual performance of equipment, corrected for jobsite conditions, altitude, temperature and pressures.
2. Submit to Architect/Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents. Provide copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes.
3. Submit the number of copies which the Contractor requires, plus two copies which will be retained by the Architect/Engineer.
4. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
5. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
6. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents.

J. Manufacturer's Instructions
1. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Architect/Engineer for delivery to Owner in quantities specified for Product Data.
2. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

K. Manufacturer's Field Reports

1. Submit reports for the Architect/Engineer's benefit as contract administrator or for the Owner.
2. Submit report within 30 days of observation to Architect/Engineer for information.
3. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the Contract Documents.

1.13 PROTECTION OF APPARATUS

A. Take precautions necessary to properly protect new apparatus from damage. Erect temporary shelters to adequately protect any apparatus stored in the open on the site. Crib apparatus above the floor of the construction. Cover apparatus in the incomplete building with tarpaulins or other protective covering. The Engineer reserves the right to reject any equipment or component which has not been properly protected.

1.14 PERMITS, FEES, ETC.

A. Arrange for a permit from the local authority. Arrange for all utility services, including sewer, water, gas and electric services as applicable. Pay any charges made by any of the utility companies due to the work on this project, including charges for metering, connection, street cutting, etc. Pay any inspection fees or other fees and charges required by ordinance, law, codes and these specifications.

1.15 TESTING

A. Perform the various tests as specified and required by the Engineer and as required by the State and local authorities. Furnish all fuel and materials necessary for making tests.

1.16 CLEANING

A. At all times during the progress of the work, keep the premises clean and free of unnecessary materials and debris. Clear any designated areas or area of materials and debris. On completion of any portion of the work, remove from the premises all tools and machinery and all debris occasioned by the work, leaving the premises free of all debris and construction dust.

1.17 COORDINATION OF TRADES

A. Items furnished under Division 23 which require electrical connections shall be coordinated with Division 26 for:
1. Voltage
2. Phase
3. Ampacity
4. No. and size of wires
5. Wiring diagrams
6. Starter size, details and location
7. Control devices and details

B. Coordinate items furnished under various sections which require plumbing connections for services, pressure, size and location of connections, type of fuel, clearances for service, auxiliary devices required, etc.

C. Insulation shall be checked against manufacturer's directions and job requirements for suitability, coverage, thickness and finish.

D. Coordinate items installed in/on finished ceilings with the ceiling construction. Conform to the reflected ceiling plan and secure details and/or samples of the ceiling materials as necessary to insure compatibility.

E. Install all items specified tight, plumb, level, square and symmetrically placed in relation to the work of other trades.

1.18 CUTTING AND PATCHING

A. Perform all construction modification and cutting required to install the work. No cutting of any structural member is permitted without specific permission from the Engineer.

B. Patching shall be done by the Contractor under the section for which the trade is specified.

1.19 PAINTING

A. All painting shall be done by the Contractor under Division 9. Following is a general outline of the required work for Divisions 23.

1. When the factory finish on any apparatus or equipment is marred, touch up and give one coat of half flat half enamel, followed by a coat of machinery enamel of a color to match the original. Paint factory primed surfaces.

2. Paint all exposed pipe, conduit, boxes, cabinets, hangers and supports and miscellaneous metal.

3. Paint all exposed sheet metal.

4. Paint all insulated surfaces exposed to view, including piping, equipment, etc. Size surfaces until a smooth, non grainy surface is obtained.

5. Generally, painting is required on all surfaces such that no exposed bare metal or insulation surface is visible.

6. Paint all surfaces above or behind perforated return air grilles or other open spaced air outlet devices with flat black paint.

1.20 SEALING AROUND PIPES, CONDUITS, DUCTS, ETC.

A. Seal all spaces between pipes and/or sleeves where they pierce walls, partitions or floors with Dow Corning No. 2000 fire resistant caulk. The packing shall effect a complete fire and/or air seal where pipes, conduits, ducts, etc., pierce walls, floors or partitions.
1.21 ACCESS PANELS

A. Wherever mechanical and/or electrical equipment is installed and where future access is required through either walls or ceilings and such cannot be obtained through the removable ceiling or through other means, provide Milcor Style "M" access doors at least 12 inches by 12 inches in size or larger if required for access. Provide access doors for all fire dampers, smoke dampers, valves, etc.

1.22 USE OF SYSTEMS

A. New Installations:

1. Do not operate mechanical equipment during construction to provide heating or cooling to the space. Make provisions to provide temporary heat during the construction process.
2. Under no circumstances shall the air handling equipment be run while wall construction is underway in any portion of the building. Take any precautions required to prevent the dust from drywall construction from contaminating the ductwork or other portions of the air handling system.
3. In order to provide protection to ducts, plenums, etc. install temporary filters over air openings until all finished painting is completed. Protect outlets, coils, etc. as necessary in each case.
4. Except for operation of equipment to prove its performance and to adjust and balance the systems, that equipment will not be operated for comfort of construction workers.

B. Immediately prior to the time that the systems are to be accepted by the Owner, carefully examined each system and if ductwork is dirty, clean by men skilled in that type of work.

1. Duct cleaning methods shall be approved by the Engineer.
2. Replace all filters and put in first class condition.

1.23 ROUGH-IN AND MAKE FINAL CONNECTION FOR EQUIPMENT

A. The shop drawings for all equipment are hereby made a part of these specifications. Rough-in for the exact item to be furnished on the job, whether in another section of the specifications or by the Owner. Refer to all drawings and other sections of the specifications for the scope of work involved for the new equipment, and by actual site examination determine the scope of the required equipment connections for the Owner furnished equipment.

B. Should any of the equipment furnished require connections of a nature different from that shown on the drawings, report the matter to the Engineer and finally connect as directed by the Engineer.

1.24 OPERATING INSTRUCTIONS

A. In cooperation with the representatives of the manufacturers of the various equipment items, carefully instruct the Owner's representatives in the proper operation of each item of equipment and of each system during the balancing and adjusting of systems.
1.25 OPERATING MANUALS

A. Prepare and submit 3 copies of the operating manuals bound in hard covers.

B. Include the following data:

1. Catalogue data of all equipment.
2. Shop drawings of all equipment.
3. Temperature control drawings (reduced in size)
4. Start-up instructions for major equipment.
5. Trouble shooting procedures for major equipment.
6. Wiring diagrams.
7. Recommended maintenance schedule for equipment.
8. Parts list for all items.
9. Name and address of each vendor.

1.26 GUARANTEE

A. Unless a longer guarantee is hereinafter called for, all work, material and equipment items shall be guaranteed for a period of one year after acceptance by the Owner. All defects in labor and materials occurring during this period shall be repaired and/or replaced. Guarantee shall be in writing and in triplicate.

1.27 COMPLETION REQUIREMENTS

A. Before acceptance and final, furnish:

1. Accurate record drawings, shown in red ink on blue line prints furnished for that purpose all changes from the original plans made during installation of the work.
2. All manufacturers' guarantees.
3. All operating manuals.

END OF SECTION - 23 00 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Flashing.
   4. Equipment curbs.
   5. Sleeves.
   6. Formed steel channel.
   7. Firestopping and accessories for HVAC Work.
   8. Equipment bases and supports.

B. Related Requirements:
   1. Section 031000 - Concrete Forming and Accessories: Placement of in concrete forms as required by this Section.
   2. Section 033000 - Cast-in-Place Concrete: Placement of concrete housekeeping pads as required by this Section.
   3. Section 078400 - Firestopping: Firestopping for placement by this Section.
   4. Section 079000 - Joint Protection: Sealant materials for placement by this Section.
   5. Section 099000 - Painting and Coating: Painting as required by this Section.
   6. Section 099635 - Chemical-Resistant Coatings: Painting as required by this Section in designated areas subject to chemical corrosion.
   7. Section 230700 - HVAC Insulation: Piping and accessory insulation as required by this Section.

1.2 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): The material used to seal or stuff or an assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire-rated construction.

1.3 REFERENCE STANDARDS

A. American Welding Society:
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

B. ASME International:
   1. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.

C. ASTM International:

D. FM Global:
1. FM - Approval Guide.

E. Intertek Testing Services (Warnock Hersey Mark):

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

G. UL:
1. UL - Fire-resistance-rated Systems and Products.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.

1.4 SUBMITTALS

A. Section 230000 Requirements for submittals.

B. Product Data:
1. Hangers and Supports: Submit manufacturer's catalog information, including load capacity.
2. Firestopping: Submit information on product characteristics, performance, and limitations.

C. Shop Drawings:
1. Indicate system layout with location, including critical dimensions and sizes.
2. Indicate pipe hanger and support locations, and detail of trapeze hangers.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrated items, and specified design numbers to seal openings to maintain fire-resistance rating of adjacent assembly.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

1.5 QUALITY ASSURANCE
A. Perform work in accordance with local codes.
B. Refer to specification section 078400 for protection of fire rated assemblies.

1.6 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years’ experience.
B. Welders: AWS qualified within previous 12 months for employed weld types.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
C. Store materials according to manufacturer instructions.
D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS
A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS
A. Manufacturers:
   1. Carpenter & Paterson Inc.
   2. Creative Systems Inc.
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.
8. Grinnel.

B. Refrigerant Piping:
1. Conform to MSS SP-58.
2. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
3. Wall Support for Pipe Sizes 3 Inches and Smaller: Cast iron hook.
5. Vertical Support: Steel riser clamp.
6. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Copper Pipe Support: Copper-plated carbon-steel ring.

C. Accessories:

2.2 FLASHING

A. Metal Flashing:
1. Material: Galvanized steel.
2. Thickness: 26 gage.

B. Metal Counterflashing:
1. Material: Galvanized steel.
2. Thickness: 22 gage.

C. Sheet Lead Flashing:
1. Waterproofing: 5 psf.
2. Soundproofing: 1 psf.

2.3 EQUIPMENT CURBS

A. Manufacturers:
1. Thybar.
2. Pate.
3. Thycurb.
4. Approved Equal.

B. Description:
2. Cant: Mitered; 3 inches.
3. Variable Step: To match root insulation.

C. Refer to construction drawings for curb heights.

2.4 SLEEVES

A. Pipes through Non-fire-rated Floors:
   1. Material: Galvanized steel.
   2. Thickness: 18 gage.

B. Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gage galvanized steel.

C. Round Ductwork: Galvanized steel.

D. Rectangular Ductwork: Galvanized steel or wood.

2.5 PIPE ROOF PENETRATION

A. Manufacturer:
   1. ChemLink ChemCurb System

B. Product:
   3. 1-Part: pourable 100% rubber sealer resistant to deterioration, melting, and shrinking.

2.6 DUCT HANGERS

A. Support ductwork in finished areas with strap hangers in accordance with SMACNA.

B. Support exposed spiral pipe ductwork with Gripple stainless steel wire rope hangers, secured with Gripple wire rope locking devices.
   1. Size wire rope in accordance with manufacturer’s loading recommendations.

2.7 FIRESTOPPING

A. Firestopping Materials: As specified in Section 078400 - Firestopping.

2.8 FIRESTOPPING ACCESSORIES

A. Installation Accessories: As specified in Section 078400 - Firestopping.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that openings are ready to receive sleeves.

B. Verify that openings are ready to receive firestopping.

3.2 INSTALLATION

A. Pipe Hangers and Supports:
   1. Comply with MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Minimum Hanger Spacing: 1/2 inch between finished covering and adjacent Work.
   4. Place hangers within 12 inches of each horizontal elbow.
   6. Support vertical piping at every floor.
   7. If piping is installed in parallel and at same elevation, provide multiple-pipe or trapeze hangers.
   9. Design hangers for pipe movement without disengagement of supported pipe.

10. Insulation:
   a. Provide clearance in hangers and from structure and other equipment for installation of insulation.

B. Equipment Bases and Supports:

1. Provide housekeeping pads of concrete as specified in Section 033000 - Cast-in-Place Concrete.
2. Minimum Size: 4 inches thick and extending 6 inches beyond supported equipment.
3. Use templates furnished with equipment to install equipment anchor bolts and accessories.
4. Provide rigid anchors for pipes after vibration isolation components are installed.

C. Flashing:

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
2. For sound control, provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms.
3. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
4. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into in to hub 8 inches minimum clear on sides with 24 X 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
5. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 X 36 inch sheet size. Fasten flashing to drain clamp device.

6. Seal floor, shower, and mop sink drains watertight to adjacent materials.

7. Curbs:
   a. Provide curbs for roof installations with minimum height of 8 inches above roofing surface.
   b. Flash and counterflash with sheet metal and seal watertight.
   c. Attach counterflashing to equipment and lap base flashing on roof curbs.
   d. Flatten and solder joints.

8. Storm Collars:
   a. Adjust storm collars tight to pipe with bolts and calk around top edge.
   b. Install storm collars above roof jacks.
   c. Screw vertical flange section to face of curb.

D. Sleeves:

   1. Exterior Watertight Entries: Seal with mechanical sleeve seals.
   2. Set sleeves in position in forms and provide reinforcing around sleeves.
   3. Sizing:
      a. Size sleeves large enough to allow for movement due to expansion and contraction.
      b. Provide for continuous insulation wrapping.
   4. Extend sleeves through floors 1 inch above finished floor level, and calk sleeves.
   5. Spaces:
      a. If piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing or firestopping, as required to maintain assembly, insulation and calk airtight.
      b. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
      c. Install chrome-plated steel escutcheons at finished surfaces.

E. Firestopping:

   1. Firestopping Materials: As specified in Section 078400 - Firestopping.

3.3 CLEANING

   A. Clean adjacent surfaces of firestopping materials.

3.4 PROTECTION

   A. Protect adjacent surfaces from damage by material installation.
3.5 ATTACHMENTS

A. Pipe Hanger Spacing:

1. Pipe Material: Copper tube.
   b. Maximum Hanger Spacing: 6 feet.
   c. Hanger Rod Diameter: 1/4 inch.

END OF SECTION – 23 05 29
SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.

B. Related Sections:

1. Section 099000 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:


1.3 SUBMITTALS

A. Section 230000 Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

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

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.
1.5 QUALIFICATIONS

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

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

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Nameplates

1. Manufacturers:
   b. Safety Sign Co.
   c. Seton Identification Products.
   d. Marking Serviced Inc.
   e. Approved equal.

B. Product Description: Laminated three-layer plastic with engraved white letters on black background color. Minimum 1-1/2" X 4" size with 16 point Helvetica font.

2.2 TAGS

A. Metal Tags

1. Manufacturers:
   a. Seton Identification Products.
   b. Marking Services Inc.
   c. Approved equal.

2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with smooth finished edges.

B. Information Tags

1. Manufacturers:
   a. Seton Identification Products.
   b. Marking Services Inc.
   c. Approved equal.
   d. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS
A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
   3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.

2.4 PIPE MARKERS
B. Plastic Pipe Markers
   1. Manufacturers:
      a. Seton Setmark.
      b. Craftmark Identification Systems.
      c. Marking Services Inc.
   2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
C. Plastic Underground Pipe Markers:
   1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service, with continuous aluminum strip for electronic tracing.

2.5 CEILING TACKS
A. Description: Steel with 3/4 inch diameter color-coded head.
B. Color code as follows:
   1. HVAC equipment: Yellow.

PART 3 - EXECUTION

3.1 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
B. Prepare surfaces in accordance with Section 099000 for stencil painting.
3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 099000.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Identify air handling units, fans, and heat transfer equipment with plastic nameplates.

G. Identify control panels and major control components outside panels with plastic nameplates. Coordinate identification with Canyon ISD authorized representative.

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

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

J. Identify 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.

K. Provide ceiling tacks to locate dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.3 SCHEDULES

A. Equipment Identification: Use plastic nameplates to identify all equipment, including but not limited to:

1. Rooftop Units
2. Fan Coil Units
3. Heat Pumps
4. Condensing Units
5. Make-Up Air Units
6. Fans
7. Boilers

END OF SECTION - 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing adjusting, and balancing of air systems.
   2. Measurement of final operating condition of HVAC systems.

B. Related Sections:
   1. Section 230923 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.

1.2 REFERENCES

A. Associated Air Balance Council:

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. Natural Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and Copy of NEBB Certificate of Conformance Certification.

F. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

G. Furnish reports in binder manuals, complete with table of contents 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.

H. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or Copy of NEBB Certificate of Conformance Certification prior to commencing system balance.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.6 QUALIFICATIONS

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

B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 SEQUENCING

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

1.8 SERVICES OF MECHANICAL CONTRACTOR

A. The Mechanical Contractor shall have all systems complete and in operational readiness prior to TAB services.

B. Complete operational readiness prior to commencement of TAB services shall include the following:
1. Construction status of building shall permit the closing of doors, etc. to obtain projected operating conditions.

2. Air Distribution Systems:
   a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by specifications.
   b. All volume and fire dampers properly located and functional. Dampers shall provide tight closure and full opening, smooth and free operation.
   c. All supply, return and exhaust grilles, registers, and diffusers installed.
   d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc. shall be blanked and/or sealed to eliminate excessive by-pass or leakage of air.
   e. All fans (supply, exhaust) are to be operating and verified for freedom from vibration, total air quantities.
   f. Drive belts shall be of proper size and tension. Heater elements shall be of proper size and rating. Provide record of motor amperage and voltage and verify that they do not exceed nameplate ratings.

3. Automatic Controls:
   a. Check that all control components are installed in accordance with project requirements and are functional, including all electrical interlock damper sequences, air resets, POC detectors.
   b. All controlling instruments calibrated and set for designed operating conditions with the exception of the room thermostats which shall be calibrated at the completion of test and balance.

C. As a part of work under Division 23 the Contractor shall make any changes in the sheaves, belts, motors and dampers as required for correct balance as required by the TAB firm. The contractor under Division 23 shall make all corrections to the mechanical installations as required to correct all deficiencies found during the TAB.

D. The Contractor shall provide and coordinate work under all sections of the specifications as required to correct, repair or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.

E. In order that all systems may be properly tested, balanced and adjusted as required herein by these specifications, the Contractor shall operate said systems for the length of time necessary to properly verify their completion and readiness for TAB and during the TAB period.

F. Project contract completion schedules shall provide time frame allowance to permit the completion of TAB services prior to occupancy. Provide simulated design condition loads as necessary.

G. Documents: The Contractor shall transmit one copy of the following records for review and comment by the TAB firm.
   1. As-installed drawings
   2. Approved fixture brochures, wiring diagrams and control diagrams.
   3. Shop drawings
   4. Instructions
   5. Valve charts

H. Permanently mark all dampers, volume controls, and other settings after TAB.
PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work. Verify the following:

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

B. Submit field reports: Report defects and deficiencies noted during performance of services, which present system balance.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Verify 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. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

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

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

G. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

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

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

C. Measure air quantities at air inlets and outlets.

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

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

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

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

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

K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches differential static pressure near building entries.
3.6 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. Packaged Roof Top Heating/Cooling Units.
   2. DX Split Systems.
   3. Make-Up Air Units.
   5. Fans.
   6. Air Filters.
   7. Air Inlets and Outlets.

B. Report Forms
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date

   2. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate building pressurization
      e. Nomenclature used throughout report
      f. Test conditions

   3. Instrument List:
      a. Instrument
      b. Manufacturer
      c. Model number
      d. Serial number
      e. Range
      f. Calibration date

   4. Electric Motors:
      a. Manufacturer
      b. Model/Frame
      c. HP/BHP and kW
      d. Phase, voltage, amperage; nameplate, actual, no load
      e. RPM
f. Service factor

   g. Starter size, rating, heater elements

   h. Sheave Make/Size/Bore

5. V-Belt Drive:

   a. Identification/location

   b. Required driven RPM

   c. Driven sheave, diameter and RPM

   d. Belt, size and quantity

   e. Motor sheave diameter and RPM

   f. Center to center distance, maximum, minimum, and actual

6. Combustion Test:

   a. Manufacturer

   b. Model number

   c. Serial number

   d. Firing rate

   e. Overfire draft

   f. Gas meter timing dial size

   g. Gas meter time per revolution

   h. Gas pressure at meter outlet

   i. Gas flow rate

   j. Heat input

   k. Burner manifold gas pressure

   l. Percent carbon monoxide (CO)

   m. Percent carbon dioxide (CO2)

   n. Percent oxygen (O2)

   o. Percent excess air

   p. Flue gas temperature at outlet

   q. Ambient temperature

   r. Net stack temperature

   s. Percent stack loss

   t. Percent combustion efficiency

   u. Heat output

7. Air Cooled Condenser:

   a. Identification/number

   b. Location

   c. Manufacturer

   d. Model number

   e. Serial number

   f. Entering DB air temperature, design and actual

   g. Leaving DB air temperature, design and actual

   h. Number of compressors

8. Cooling Coil Data:

   a. Identification/number
b. Location

c. Service

d. Manufacturer

e. Air flow, design and actual

f. Entering air DB temperature, design and actual

g. Entering air WB temperature, design and actual

h. Leaving air DB temperature, design and actual

i. Leaving air WB temperature, design and actual

j. Saturated suction temperature, design and actual

k. Air pressure drop, design and actual

9. Heating Coil Data:

a. Identification/number

b. Location

c. Service

d. Manufacturer

e. Air flow, design and actual

f. Entering air temperature, design and actual

g. Leaving air temperature, design and actual

h. Air pressure drop, design and actual

10. Fan Coil Data:

a. Manufacturer

b. Identification/number

c. Location

d. Model number

e. Size

f. Air flow, design and actual

g. Entering air temperature, design and actual

h. Leaving air temperature, design and actual

11. Air Moving Equipment:

a. Location

b. Manufacturer

c. Model number

d. Serial number

e. Arrangement/Class/Discharge

f. Air flow, specified and actual

g. Return air flow, specified and actual

h. Outside air flow, specified and actual

i. Total static pressure (total external), specified and actual

j. Inlet pressure

k. Discharge pressure

l. Sheave Make/Size/Bore

m. Number of Belts/Make/Size

n. Fan RPM

12. Return Air/Outside Air Data:
a. Identification/location 
b. Design air flow 
c. Actual air flow 
d. Design return air flow 
e. Actual return air flow 
f. Design outside air flow 
g. Actual outside air flow 
h. Return air temperature 
i. Outside air temperature 
j. Required mixed air temperature
k. Actual mixed air temperature 
l. Design outside/return air ratio 
m. Actual outside/return air ratio

13. Exhaust Fan Data:

a. Location 
b. Manufacturer 
c. Model number 
d. Serial number 
e. Air flow, specified and actual 
f. Total static pressure (total external), specified and actual 
g. Inlet pressure 
h. Discharge pressure 
i. Sheave Make/Size/Bore 
j. Number of Belts/Make/Size 
k. Fan RPM

14. Duct Traverse:

a. System zone/branch 
b. Duct size 
c. Area 
d. Design velocity 
e. Design air flow 
f. Test velocity 
g. Test air flow 
h. Duct static pressure 
i. Air temperature 
j. Air correction factor

15. Duct Leak Test:

a. Description of ductwork under test 
b. Duct design operating pressure 
c. Duct design test static pressure 
d. Duct capacity, air flow 
e. Maximum allowable leakage duct capacity times leak factor 
f. Test apparatus 

1) Blower
2) Orifice, tube size
3) Orifice size
4) Calibrated

g. Test static pressure
h. Test orifice differential pressure
i. Leakage

16. Air Distribution Test Sheet:

a. Air terminal number
b. Room number/location
c. Terminal type
d. Terminal size
e. Area factor
f. Design velocity
g. Design air flow
h. Test (final) velocity
i. Test (final) air flow
j. Percent of design air flow

END OF SECTION – 23 05 93
SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.

B. Related Sections:

1. Section 078400 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 099000 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 230529 – Hangers and supports for HVAC Piping and Equipment. Exception requirements for inserts for placement.

1.2 REFERENCES

A. ASTM International:

4. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

B. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:

1.3 SUBMITTALS

A. Section 230000: Submittal procedures.
B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.
1.6  DELIVERY, STORAGE, AND HANDLING
   A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
   B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.7  ENVIRONMENTAL REQUIREMENTS
   A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
   B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.8  FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1  MANUFACTURER
   A. Glass Fiber and Mineral Fiber Insulation
      1. Manufacturers:
         a. CertainTeed.
         b. Knauf.
         c. John Mansville.
         d. Owens-Corning.
   B. Closed Cell Elastomeric Insulation
      1. Manufacturers:
         a. Armaflex LLC.
         b. Aeroflex.
         c. Aerocell.

2.2  PIPE INSULATION
   A. TYPE P-1: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.
      1. Thermal Conductivity: 0.27 at 75 degrees F.
      2. Maximum Service Temperature: 250 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F.

2.3 PIPE INSULATION JACKETS

A. Aluminum Pipe Jacket:
   1. Thickness: 0.020 inch thick sheet for indoor application; 0.025 inch thick sheet for outdoor application.
   2. Finish: Smooth.
   4. Fittings: 0.024 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 1/2 inch wide; 0.020 inch thick stainless steel.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.
   1. Childers CP-82.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Shields for piping 1-1/2 inches diameter and smaller:
   1. Galvanized steel insulation protection shield.
   2. MSS SP-69, Type 40.
   3. Length: Based on pipe size and insulation thickness.


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

F. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

G. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

H. Adhesives: Compatible with insulation.

2.5 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Maximum Operating Temperature: 250 degrees F.
   3. Density: 1.0 pound per cubic foot.
B. TYPE D-2: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.
   1. Thermal Conductivity: 0.25 at 75 degrees F.
   2. Maximum Operating Temperature: 250 degrees F.
   3. Maximum Air Velocity: 5,000 feet per minute.
   4. Minimum Noise Reduction Criteria: 0.70 for 1 inch thickness.

C. TYPE D-3: Ceramic Fiber Duct Wrap
   1. Manufacturer:
      a. Unifrax Fyrewrap Duct Insulation
   2. Insulation: ASTM C553; flexible, noncombustible blanket.
      a. ‘K’ value: ASTM C518, 0.27 at 75 degrees F.
      b. Maximum service temperature: 250 degrees F.
      c. Maximum moisture absorption: 0.20 percent by volume.

2.6 DUCTWORK INSULATION JACKETS
A. Vapor Retarder Jacket:
   1. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
   2. Secure with pressure sensitive tape.

2.7 DUCTWORK INSULATION ACCESSORIES
A. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof type.

D. Liner Fasteners: Galvanized steel, impact applied with integral head.

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

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.
   1. Manufacturers:
      a. Childers Mover CP-89.
      b. Fosters Model 85-23.
      c. Marathon Model 224.
   2. Waterproof, ASTM E162 fire-retardant type.
I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping, equipment, and ductwork has been tested before applying insulation materials.
B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Install in accordance with NAIMA National Insulation Standards.
B. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
C. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 078400 for penetrations of assemblies with fire resistance rating greater than one hour.
D. Inserts and Shields:
   1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
E. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

3.3 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.
B. Insulated ductwork conveying air below ambient temperature:
   1. Provide insulation with vapor retarder jackets.
   2. Finish with tape and vapor retarder 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.
C. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. External Glass Fiber Duct Insulation:

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

E. Duct Liner:

1. Adhere insulation with adhesive for 100 percent coverage.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

F. Kitchen Exhaust Ductwork:

1. Cover duct by wrapping with insulation using checkerboard overlap method.
2. Overlap seams of each method by 3 inches.
3. Attach insulation using steel banding or by welded pins and clips.
4. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

G. Prepare duct insulation for finish painting.

3.4 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

1. Refrigerant Suction:
   a. Type: P-1.
   b. Thickness: 0.75 inch

B. Ductwork Insulation Schedule:

1. Rectangular Supply Ducts - Internally Insulated:
   a. Type: D-2.
   b. Thickness: 1.5 inch
2. Rectangular Return Ducts - Internally Insulated:
   a. Type: D-2.
   b. Thickness: 1.5 inch

3. Round Supply Ducts - Externally Insulated, Installed Thickness:
   a. Type: D-1.
   b. Thickness: 2.0 inches

4. Make-Up Air Ducts - Externally Insulated, Installed Thickness:
   a. Type: D-1.
   b. Thickness: 2.0 inches

5. Kitchen Exhaust:
   a. Type: D-3.
   b. Thickness: 2 layers, 1.5 inches
      1) Provide additional glass cloth covering

6. Transfer Air Ducts - Internally Insulated:
   a. Type: D-2.
   b. Thickness: 1.5 inches

END OF SECTION - 23 07 00
SECTION 23 09 23 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control wiring, enclosures, and owner provided equipment.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 SYSTEM DESCRIPTION

A. This Section includes the Facility Management Control System (FMCS) equipment for HVAC systems and components.

B. Manufacturers:
   1. IDEC - compliant with Owner’s current system. No Exceptions.

C. Under this contract, the Contractor shall provide the following:
   1. All control wiring, installed
      a. The Contractor shall terminate all control wiring at HVAC equipment and thermostats.
      b. Control wiring termination at Intermediate IDEC controllers, Main IDEC controller, and IDEC relays will be performed by owner.
   2. Junction boxes and cabinets for mounting of control equipment.
   3. 120V damper actuators as indicated on drawings.

D. The Owner will mount and terminate all IDEC controllers and IDEC relays.

E. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Shop Drawings: Indicate the following:
   1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

D. Control wiring for each service item. Indicate color coding, conductor quantity, and conductor gage.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

   1. Submit data specified in "Submittals" in final "Record Documents" form.

B. Operation and Maintenance Data:

   1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section with Owner’s Representative.

   1. Items to be coordinated with Owner’s Representative shall include but not limited to the following:
      a. Exact location of enclosure to house IDEC controllers and IDEC relays with owner.
      b. Routing of control wiring bus.
      c. Excess wiring requirements inside enclosures.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Contractor shall provide a 1 year warranty for all material and workmanship for control wiring and components provided as part of this project.

PART 2 - PRODUCTS

2.1 WIRING AND RACEWAYS

A. Raceways: Materials as specified in the applicable sections of Division 16.
B. Wiring:

1. General Cable Part#
   a. Control Wire:
      1) C4310A - 8 Conductor, 18 AWG Solid
   b. Bus Control Wiring:
      1) C6351 - 2 Conductor, 20 AWG
   c. Thermostat Wire:
      1) E1001S - 4 Conductor, 22 AWG

2. All control wiring shall conform with Canyon ISD standard color configuration. Coordinate requirements with owner prior to ordering.

3. No Substitutes

2.2 ENCLOSURES

A. IDEC Intermediate and IDEC Main enclosures shall be provided and installed as indicated on drawings.

B. Relay enclosures shall be provided and installed as indicated on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Control devices are to be installed in steel enclosures mounted above the corridor ceiling, beneath the unit under control by those devices.

B. Labeling: Label all wiring.

C. Install cabinets level and plumb.

D. Verify location of room thermostats and other exposed control sensors with plans and room details before installation.

E. Mount wall boxes for space sensors in all locations at 48 inches above floor.

F. Mount all control cabinets for rooftop unit controllers above the ceiling in corridors. Refer to the drawings for locations. Mount controllers near the main door, off to one side – do not mount directly over door.

G. The UNC will be mounted in the closet as indicated on the drawings.

3.2 ELECTRICAL WIRING

A. All control and interlock wiring shall comply with national and local electrical codes.

B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway per NEC and Division 16 requirements.
C. All low voltage wiring shall meet NEC Class 2 requirements. (Low voltage power circuits shall be sub-fused when required to meet Class 2 current limit.)

D. All NEC Class 2 wiring shall be installed in raceway.
   1. Exception: Where NEC Class 2 (current limited) wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used, provided that cables are UL Listed for the intended application. For example, plenums shall be UL Listed specifically for that purpose.

E. All wiring in mechanical, electrical or service rooms - or where subject to mechanical damage - shall be installed in raceway at levels below 10 ft.

F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

G. Do not install wiring in raceway containing tubing.

H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it, and neatly tied at 10ft intervals.

I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping or ceiling suspension systems.

J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be made at a terminal block or wire nut at junction box.

K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120v. If only higher voltages are available, the contractor shall provide step-down transformers.

M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

O. Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer’s recommendation and NEC requirements, except as noted elsewhere.

P. Include one pull string in each raceway 1 inch or larger.

Q. Use coded conductors throughout with different colored conductors.

R. Conceal all raceways, except within mechanical, electrical or service rooms. Install raceway to maintain a minimum clearance of 15 cm [6”] from high-temperature equipment (e.g. steam pipes or flues).
S. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

T. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

U. The owner shall terminate all control and interlock wiring, and shall maintain updated wiring diagrams with terminations identified at the job site.

V. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3ft in length and shall be supported at each end. Flexible metal raceway less than 3/4” electrical trade size shall not be used. In areas exposed to moisture - including chiller and boiler rooms - liquid-tight, flexible metal raceways shall be used.

W. Raceway must be rigidly installed, adequately supported, properly reamed at both ends and left clean and free of obstructions. Raceway sections shall be joined with couplings (per code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.3 COMMUNICATION WIRING

A. Include the following schedule to identify type of alarms identified with input and output points contained in previous schedules.

B. The contractor shall adhere to the items listed in the “Wiring” Article in Part 3 of the specification.

C. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturers installation recommendations for all communication cabling.

D. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

E. Maximum pulling, tension and bend radius for cable installation as specified by the cable manufacturer shall not be exceed during the installation.

F. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

G. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer’s instructions.
H. All runs of communication wiring shall be unspliced length when that length is commercially available.

I. All communication wiring shall be labeled to indicate origination and destination data.

J. Grounding of coaxial cable shall be in accordance with NEC regulations Article on Communication Circuits, Cable and Protector Grounding.

END OF SECTION - 23 09 23
SECTION 23 23 00 - REFRIGERANT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Refrigerant piping.
2. Refrigerant.

B. Related Sections:
1. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, [and firestopping] for placement by this section.
2. Section 230553 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
3. Section 230700 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 750 - Thermostatic Refrigerant Expansion Valves.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. American Society of Mechanical Engineers:
1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:
   1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION
   A. Refrigerant piping system to connect outdoor condensing unit to indoor fan coil unit.
   B. Provide pipe hangers and supports in accordance with ASME B31.5.

1.4 SUBMITTALS
   A. Section 230000: Submittal procedures.
   B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
   C. Product Data:
      1. Piping: Submit data on pipe materials, fittings, and accessories.
      2. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
   D. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE
   A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

1.7 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
   B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years' documented experience.
1.8 DELIVERY, STORAGE, AND HANDLING
   A. Section 016000 - Product Requirements: Product storage and handling requirements.
   B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
   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.

1.9 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING
   A. Copper Tubing: ASTM B280, drawn.
      2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 UNIONS, FLANGES, AND COUPLINGS
   A. 2 inches and Smaller:
      1. Copper Pipe: Bronze, soldered joints.

2.3 REFRIGERANT
   A. Refrigerant: ASHRAE 34
      1. R-410a

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify excavations are to required grade, dry, and not over-excavated.
3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.
D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.5, and MSS SP 89.
B. Support horizontal piping hangers as scheduled.
C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
D. Place hangers within 12 inches of each horizontal elbow.
E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
H. Provide copper plated hangers and supports for copper piping.
I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.
B. Install piping to conserve building space, and not interfere with use of space.
C. Group piping whenever practical at common elevations.
D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 230529.
E. Install pipe identification in accordance with Section 230553.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Provide access where valves and fittings are not exposed.

H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

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

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 9.

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

M. Insulate piping; refer to Section 230700.

N. Fully charge completed system with refrigerant after testing.

O. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Install refrigerant piping in accordance with ASME B31.5.

3.5 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using halide torch.

C. Repair leaks.

D. Retest until no leaks are detected.
SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Duct materials.
   2. Insulated flexible ducts.
   5. Double-wall, insulated, spiral round ducts.
   6. Double-wall, insulated, spiral flat oval ducts.
   7. Transverse duct connection system.
   8. Casings.
  11. Duct cleaning.

B. Related Requirements:
   1. Section 099000 - Painting and Coating: Requirements for painting or coating as specified in this Section.
   2. Section 233300 - Air Duct Accessories: Requirements for duct accessories as specified in this Section.

1.2 REFERENCE STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

B. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.
   2. AWS D1.2 - Structural Welding Code - Aluminum.

C. ASTM International:
5. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

D. International Code Council:

2. International Mechanical Code (IMC).

E. NFPA:


F. Sheet Metal and Air Conditioning Contractors' National Association:

2. SMACNA 1767 - Kitchen Ventilation Systems and Food Service Equipment Guidelines.
3. SMACNA 1884 - Fibrous Glass Duct Construction Standards.

G. UL:

1. UL 181 - Factory-Made Air Ducts and Air Connectors.
2. UL 181A - Closure Systems for Use With Rigid Air Ducts.
3. UL 1978 - Grease Ducts.

1.3 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is permitted except by written permission from engineer.

B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.
1.4 SUBMITTALS

A. Section 230000: Requirements for submittals.

B. Product Data: Submit manufacturer information for duct materials and connections.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

E. Test and Evaluation Reports: Indicate pressure tests performed, including date, section tested, test pressure, and leakage rate according to SMACNA 016.

F. Manufacturer Instructions:
   1. Submit detailed instructions on installation requirements, including storage and handling procedures.
   2. Submit special procedures for glass-fiber ducts.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents:
   1. Record actual locations of ducts and duct fittings.
   2. Record changes in fitting location and type.
   3. Show additional fittings used.

1.6 QUALITY ASSURANCE

A. Perform Work according to SMACNA 1884 and 1966.

B. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

1.7 QUALIFICATIONS

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

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.
C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS
   A. Minimum Conditions: Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.
   B. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.

1.10 EXISTING CONDITIONS
   A. Field Measurements:
      1. Verify field measurements prior to fabrication.
      2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 DUCT MATERIALS
   A. Galvanized-Steel Ducts:
      2. Quality: Lock forming.
      3. Finish: G90 zinc coating according to ASTM A90.
   B. Steel Ducts: Comply with ASTM A1008.
   C. Stainless-Steel Ducts: Comply with ASTM A240, Type 304.
   D. Fasteners: Rivets, bolts, or sheet metal screws.
   E. Hanger Rod:
      1. Material: Galvanized steel.
      2. Comply with ASTM A36.
      3. Type: Threaded continuously.

2.2 DUCTWORK FABRICATION
   A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. All duct sizes indicated on the drawings are clear inside dimensions. Increase sheet metal size as required to accommodate duct liner where required. Refer to Section 15080.

D. Transverse duct joints: Refer to manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing and joint reinforcements.
   1. TDC® (T-25a) / TDF® (T-25b) / T-24 joints are not acceptable for duct pressure classes over 2 in w.g. or duct sizes over 30 inches.

E. Make longitudinal seams with appropriate lock joint, sealed with mastic sealant.
   1. Use Pittsburgh lock on fittings
      Snaplock allowed on straight duct joints. Secure each end of joint with sheet metal screw.

F. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide turning vanes.
   1. Harper double wall turning vanes fabricated from same material as duct.
   2. Tab spacing in conformance with SMACNA Standard. Use all tabs.

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

H. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA Duct Construction Standard with minimum 4-inch cemented slip joint, brazed or electric welded, with the following exceptions:
   1. Joints 0 inches-20 inches diameter: interior slip coupling beaded at center, fastened to duct, with sealing compound applied continuously around joint before assembling and after fastening.
   2. Joints 21 inches –72 inches diameter: 3 piece gasketed, flanged joints consisting of two internal flanges with integral mastic sealant split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges.
      a. Ductmate Spiralmate or equal.

I. Provide standard 45-degree lateral wye takeoffs unless otherwise indicated where 90-degree conical tee connections may be used.

J. All ductwork shall be minimally sealed as defined for a Class C sealant class, according to SMACNA Duct Construction Standards, regardless of actual pressure class. Class A and Class B sealant classes still apply to applicable pressure classes.

2.3 INSULATED FLEXIBLE DUCTS

A. Description:
1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
2. Insulation: Fiberglass.
3. Vapor Barrier Film: Aluminized.
4. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
5. Maximum Velocity: 4,000 fpm.
6. Temperature Range: Minus 20 to plus 210 degrees F.

2.4 DOUBLE-WALL, INSULATED, SPIRAL ROUND DUCTS

A. Manufacturers:
   1. Duct Direct
   2. Lewis & Lambert
   3. Spiral Pipe of Texas

B. Description:
   1. Machine made from round spiral lockseam duct with light reinforcing corrugations and galvanized-steel outer wall.
   2. Insulation:
      b. Thickness: 2 inches.
   3. Inner Wall: Perforated galvanized steel.

C. Minimum Duct Wall Thicknesses:
   1. Diameter 2 to 14 Inches 26 gage.
   2. Diameter 16 to 26 Inches 24 gage.
   3. Diameter 28 to 36 Inches 22 gage.
   4. Diameter 38 to 50 Inches 20 gage.
   5. Diameter 52 to 60 Inches 18 gage.

D. Minimum Fittings Wall Thicknesses:
   1. Diameter 2 to 14 Inches 24 gage.
   2. Diameter 16 to 26 Inches 22 gage.
   3. Diameter 28 to 50 Inches 20 gage.
   4. Diameter 52 to 60 Inches 18 gage.

2.5 DOUBLE-WALL, INSULATED, SPIRAL FLAT OVAL DUCTS

A. Manufacturers:
   1. Duct Direct
   2. Lewis & Lambert
   3. Spiral Pipe of Texas
B. Description:
   1. Machine made from round spiral lockseam duct with light reinforcing corrugations and galvanized-steel outer wall.
   2. Insulation:
      b. Thickness: 2 inches.
   3. Inner Wall: Perforated galvanized steel.

C. Minimum Duct Wall Thicknesses:
   1. Major Axis Dimension 7 to 24 Inches 24 gage.
   2. Major Axis Dimension 25 to 48 Inches 22 gage.
   3. Major Axis Dimension 50 to 70 Inches 20 gage.
   4. Major Axis Dimension 72 to 82 Inches 18 gage.
   5. Major Axis Dimension 84 Inches 16 gage.

D. Minimum Fittings Wall Thicknesses:
   1. Major Axis Dimension 7 to 36 Inches 20 gage.
   2. Major Axis Dimension 37 to 60 Inches 18 gage.

2.6 KITCHEN HOOD EXHAUST DUCTWORK
   A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.
   B. Construct of 18 gage stainless steel, using continuous external welded joints.

2.7 TRANSVERSE DUCT CONNECTION SYSTEM
   A. Manufacturers:
      1. Ductmate
   B. Application:
      1. Ducts where either dimension is 30 inches or larger.
   C. Description:
      1. Interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
         a. Gosket shall meet Mil-C 18969B, Type II Class B.
      2. Rigidity Class Connection: SMACNA "E." "F." or "J."
2.8 ACCESSORIES

A. Hangers and Supports:

2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
3. Strap and Rod Sizes:

4. Trapeze and Riser Supports:

5. Support exposed spiral pipe ductwork with Gripple stainless steel wire rope hangers, secured with Gipple wire rope locking devices.
   a. Size wire rope in accordance with manufacturer's loading recommendations.

2.9 SEALERS

A. Flexible water based adhesive sealant designed for use in all pressure duct systems.

B. UL listed and conforming to ASTM E84.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify sizes of equipment connections before fabricating transitions.

3.2 PREPARATION

A. Install temporary closures of metal or taped PE on open ductwork to prevent construction dust from entering ductwork system.

3.3 INSTALLATION

A. Install and seal ducts according to SMACNA 1966.

B. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches and smaller.

C. Hanger and Supports:

1. Fabricate and support ducts according to SMACNA 1966.
2. Threaded Rods: Provide double nuts and lock washers.

3. Building Attachments:
   a. Provide structural-steel fasteners appropriate for construction materials to which hangers are being attached.

4. Hanger Spacing:
   b. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
   c. Extend strap supports down both sides of ducts and turn under bottom at least 1 inch.
   d. Secure hanger to sides and bottom of ducts with sheet metal screws.

5. Hangers Exposed to View: Provide threaded rod and angle or channel supports.

6. Vertical Ducts:
   a. Support with steel angles or channel secured to sides of duct with welds, bolts, sheet metal screws, or blind rivets.
   b. Support at each floor and at maximum intervals of 16 feet.

7. Upper Attachments:
   a. Attach to structures.
   b. Selection and Sizing: Provide pull-out, tension, and shear capacities as required for supported loads and building materials.

8. Penetrations:
   a. Avoid penetrations of ducts with hanger rods.
   b. If unavoidable, provide airtight rubber grommets at penetrations.

D. Buried Ducts:
   1. Slope to plenums or low pump-out points at slope of 1:500.
   2. Provide access doors for inspection.

E. Connect flexible ducts to metal ducts with draw bands plus adhesive.

F. Plenum Doors:
   1. Location: 6 to 12 inches above floor.
   2. Arrange door swing such that fan static pressure holds door in closed position.

G. Kitchen Range Hoods:
   1. According to NFPA 96.
   2. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout.
   3. Exhaust Ducts: Provide stainless-steel ductwork where exposed to view, and stainless steel where ducts are concealed.
H. Exhaust Outlet Locations:

1. Minimum Distance from Property Lines: 3 feet.
2. Minimum Distance from Building Openings: 3 feet.
3. Minimum Distance from Outside Air Intakes: 10 feet.

I. Interface with Other Work:

1. Install openings in ductwork as required to accommodate thermometers and controllers.
2. Install pitot tube openings for testing of systems, complete with metal can with spring device or screw to prevent air leakage.
3. If openings are provided in insulated ductwork, install insulation material inside metal ring.
4. Connect diffusers to low-pressure ducts with 3-foot maximum length of flexible duct held in place with strap or clamp.

3.4 FIELD QUALITY CONTROL

A. Testing:

1. Test ductwork prior to installation of access doors, take-offs, and other taps.
2. All leak testing to be witnessed by the engineer. Provide 72 hours notice prior to testing.
3. Perform testing on first section of ductwork installed to verify quality of workmanship before majority of ductwork is installed.
4. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
   a. Use a certified orifice tube for measuring leakage.
   b. Define section of duct to be tested, blank off and seal.
   c. Determine percentage of system being tested.
   d. Determine allowable leakage (cfm) for the section being tested, in relation to the percentage of the duct being tested.
   e. Pressurize to operating pressure and repair and significant or audible leak.
   f. Re-pressurize and measure leakage.
   g. Repeat until measured leakage is less than allowable leakage.
5. Concealed Grease Ducts:
   a. Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test according to IMC in presence of authority having jurisdiction.
   b. Perform light test by pulling minimum 100-W light through duct and observing for light leaks at duct joints.
   c. Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

3.5 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust.
B. To obtain sufficient airflow, clean one half of system completely before proceeding to other half.

C. Provide adequate access into ductwork for cleaning purposes.

3.6 SCHEDULES

A. Ductwork Material Schedule:

1. Supply: Steel.
2. General Exhaust: Steel.

B. Ductwork Pressure Class Schedule:

2. Return and Relief: 2-inch wg.
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Volume control dampers.
   2. Flexible duct connections.
   3. Duct test holes.

B. Related Sections:

   1. Section 233100 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
   1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:

C. National Fire Protection Association:

D. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
   1. Flexible duct connections.
   2. Volume control dampers.
   3. Duct access doors.
   4. Duct test holes.
C. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Dampers tested, rated and labeled in accordance with the latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

C. Storage: Store materials in a dry area indoor, protected from damage.

D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 COORDINATION

A. Coordinate Work where appropriate with building control Work.

PART 2 - PRODUCTS

2.1 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Rectangular Manual Damper: Ruskin MD15
1. Up to 36 inches x 12 inches: 22 gage galvanized steel frame, 22 gage galvanized steel blade with center V groove for reinforcement, 3/8 inch square shaft, with molded synthetic bearings and 2 inch stand off bracket.
2. Over 36 inches x 12 inches: 18 gauge galvanized steel formed hat channel frame, 18 gauge galvanized steel single skin blade with 3 longitudinal grooves for reinforcement, hexagonal steel shaft locked into damper blade, with molded synthetic bearings and 2 inch stand off bracket.

C. Round In-Line Butterfly dampers: Flexmaster or Buckley

1. Flexmaster Model SLB03 manual damper.
3. Overall length – 7 inches
4. Round outlet fabricated with rolled stiffener bead for strength.
5. Provide with 2 inch stand-off brackets and locking hand quadrant.

D. Round Runout Balancing Dampers:

1. Flexmaster or Buckley.
2. Equal to Flexmaster STOD dampers with insulation build out brackets.
4. Round outlet fabricated with rolled stiffener bead for strength.
5. Provide with 2 inch stand-off brackets and locking hand quadrant.

E. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.

F. Concealed Damper Operators:

1. On ducts behind non-removable ceilings or furrings, or other construction that is not easily removable to permit access to the ducts, provide devices equal to Young Regulator Co. 927C miter gear with 315 concealed regulator.

2.2 AUTOMATIC CONTROL DAMPERS:

A. Provide where indicated on the drawings. Provide with or without actuators as indicated.

B. Manufacturer: Pottorff TICD-52 low leakage control damper, heavy gage insulated aluminum airfoil shaped blades, extruded vinyl lade seals, stainless steel flexible jamb seals, molded synthetic bearings, ½ inch diameter control shaft, opposed blade operation.

C. Actuator:

1. Electric: 120 V AC, 60 Hz, two-position.
2.3 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

B. Connector: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
3. Metal: 3 inch wide, 24 gage galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify ducts and equipment installation are ready for accessories.

B. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

A. Install in accordance with NFPA 90A and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 233100 for duct construction and pressure class.

B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

C. Access Doors: Install access doors at the following locations and as indicated on Drawings:

   1. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.

D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.

E. Install temporary duct test holes required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

END OF SECTION - 23 33 00
SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Downblast centrifugal roof fans.
   2. Upblast centrifugal roof fans.

B. Related Sections:
   1. Section 230513 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
   2. Section 230700 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
   3. Section 233100 – HBAC Ducts and Casings: Product requirements for hangers for placement by this section.
   4. Section 233300 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
   2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
   5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.
   2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. Underwriters Laboratories Inc.:
   1. UL 705 - Power Ventilators.
1.3 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturer instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

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

D. Balance Quality: Conform to AMCA 204.

1.6 QUALIFICATIONS

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.
1.9 WARRANTY

A. Furnish one-year manufacturer's warranty for fans.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF FANS

A. Manufacturers:
1. Loren Cook Company.
2. Greenheck Corp.

B. Product Requirements:
1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
3. Fabrication: Conform to AMCA 99.
4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

C. General:
1. Roof exhaust fans are centrifugal, belt-driven type.
2. Construction of the fan housing is heavy gauge aluminum.
3. Include built in lifting lugs incorporated into the frame of the fan.

D. Housing:
1. All spun parts shall have a rolled bead for added rigidity
2. Spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.
3. Removable top cap with stainless steel quick release catches.

E. Fan:
1. Fan wheel is all-aluminum, centrifugal blower type with backward inclined blades and a tapered inlet shroud.
2. Wheels are statically and dynamically balanced.
3. Inlet cone of aluminum.

F. Motor and Drive:
1. Motor enclosed in a weather-tight compartment, separate from the exhaust airstream.
2. Air for cooling the motor shall be supplied to the motor compartment by way of an air passage, from an area free of contaminated exhaust fumes.
3. Motors: heavy duty, permanently lubricated, sealed ball bearing type.
4. Drives: heavy duty cast iron type, keyed to the fan and motor shafts, variable pitch.
5. Fan shaft: steel construction, turned, ground and polished to precise tolerances in relationship to the hub and bearings.

6. Drive belts: oil-resistant, non-static, non-sparking type with life expectancy of over 24,000 hours.

7. Bearings: flanged and of the permanently lubricated, permanently sealed, ball bearing type capable of over 200,000 hours bearing life.

8. The entire drive assembly and wheel shall be removable, as a complete unit, from the support structure without disassembling the external fan housing.

9. The complete drive assembly shall be mounted on rubber vibration isolation.

10. Direct drive units:
   a. Identical construction as belt drive units, except for drives, belts, and fan shaft bearings.
   b. Type B construction.

G. Accessories:

1. Roof Curb: Galvanized steel with continuously welded seams, built-in cant strips, one inch insulation and curb bottom and factory installed nailer strip.
   a. Refer to mechanical schedules for height of roof curb.

2. Disconnect Switch: Factory-wired, non-fusible, in housing for thermal overload protected motor.


4. Provide all ECM direct drive fans with factory wired, motor mounted controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Secure roof fans with cadmium plated steel lag screws to roof curb.

B. Install flexible connections between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Install backdraft dampers on inlet to roof exhaust fans.

D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.

E. Install safety screen where inlet or outlet is exposed.

F. Install backdraft dampers on discharge of exhaust fans.

G. Provide sheaves required for final air balance.

H. Do not operate fans in normal operation until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation.

I. Roof mounted fans to be installed level. Shim curb as required, regardless of roof slope.
3.2 CLEANING
A. Vacuum clean coils and inside of fan cabinet.

3.3 DEMONSTRATION
A. Demonstrate fan operation and maintenance procedures.

END OF SECTION – 23 34 00
SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
4. Roof hoods.
5. FEMA Grilles.
7. Kitchen hood fire extinguishing system.

B. Related Sections:

1. Section 233300 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of air outlets and inlets.
1.5 QUALIFICATIONS

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

1.6 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish one-year manufacturer's warranty for air outlets and inlets.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

A. Manufacturers:

1. Price Industries.
2. Titus.
5. Nailor.

B. Product Description: Type: Round, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sector baffles where indicated. Diffuser collar not more than 1 inch above ceiling. In plaster ceilings, furnish plaster ring and ceiling plaque.

C. Fabrication: Steel with baked enamel off-white finish.

2.2 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:

1. Price Industries.
2. Titus.
5. Nailor.

B. Type: Square multi-louvered diffuser to discharge air in pattern as indicated on drawings.

C. Frame: Inverted T-bar type. In plaster ceilings, furnish plaster frame and ceiling frame.

D. Fabrication: Steel with baked enamel off-white finish.
2.3 CEILING SLOT DIFFUSERS

A. Manufacturers:
   1. Price Industries.
   2. Titus.
   5. Nailor.

B. Type: Continuous slot size and quantity indicated on drawings with adjustable vanes for left, right or vertical discharge.

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

D. Frame: 1-1/4 inch margin with concealed mounting and gasket mitered end border.

E. Plenum: Integral, galvanized steel, insulated; for ceiling mounted diffusers.

F. Blank-Off: Provide blank cap for all inactive sidewall grilles, as indicated on construction drawings.

2.4 SIDEWALL SUPPLY AND RETURN NOZZLES

A. Manufacturer: Seiho, NO EXCEPTIONS

B. Type: Round, independently adjustable turbo nozzles, diffuser to discharge air in pattern as indicated on drawings. Multi-diffuser assemblies shall be mounted in aluminum rectangular panels with screw holes on face plate.

C. Fabrication: Aluminum with brushed aluminum finish.

2.5 SIDEWALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
   1. Price Industries.
   2. Titus.
   5. Nailor.

B. Type: Streamlined blades, 3/4-inch minimum depth, 1/2 inch maximum spacing, with blades set at 45 degrees, horizontal face.

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

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel finish.
2.6 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
   1. Price Industries.
   2. Titus.
   5. Nailor.

B. Type: Fixed grilles of 1/2 x 1/2 x 1/2 inch louvers for all modules 24 x 24 and smaller; 1/2 x 1/2 x 1 inch louvers for all modules larger than 24 x 24.

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

D. Frame: 1-1/4-inch margin with channel lay-in frame for suspended grid ceilings.

2.7 FEMA RATED RECTANGULAR LOUVERS

A. Manufacturers:
   1. Potterff.
   2. Greenheck Corp.
   3. Ruskin Manufacturing.
   4. NCA.

B. Product Description: Stationary FEMA rated steel grille.

C. Type: 6 inch deep 1/4 inch steel frame with inverted 3/16” angle iron blades.

D. Fabrication: Louver shall be designed to meet FEMA 320 or FEMA 361 guidelines for shelters or safe rooms. Capable of withstanding design loads of 260 psf to 300 psf produced by extreme wind phenomenon.

E. Mounting:
   1. Provide with factory welded 14 inch steel sleeve.
   2. Provide with two (2) 1-1/2 inch angle iron frames to be field welded on each side of sleeve to secure in FEMA rated concrete lid.
      a. Refer to detail on drawings.


2.8 VENTILATION HOODS

A. Manufacturers:
   1. Loren Cook Company.
   2. Greenheck Corp.
B. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Fabricate of aluminum, minimum 16 gage base and 18 gage hood. Furnish removable hood; bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, standard mill aluminum finish.

D. Fabricate hood outlet area minimum of twice throat area.

E. Roof Curb: 24 inch high galvanized steel construction with continuously welded seams 1 inch insulation and curb bottom, and factory installed nailer strip.

2.9 KITCHEN EXHAUST HOOD

A. Manufacturer:
   2. Greenheck Corp.

B. General:
   1. Self compensating type with conditioned make-up air from front mounted perforated supply plenum.
   2. Size as detailed on the drawings.
   3. U.L. 710 Listed, NSF Listed and conforming with the latest requirements of NFPA 96.

C. Material:
   1. All exposed hood areas fabricated of stainless steel, 18 gauge minimum thickness, with a # 3 polish.
   2. Unexposed hood areas fabricated of galvanized steel, 18 gauge minimum thickness.

D. Construction:
   1. All seams and joints heliarc welded liquid tight.
   2. ground and polished to match original finish of metal.
   3. All edges de-burred.

E. Grease filters:
   1. UL Classified heavy gauge aluminum double frame construction with flame barrier protection.
   2. Filters are self balancing, self draining, and easily removable for cleaning.
   3. Grease drains from integral grease trough to a removable and easily cleanable pull out grease container located out of the air stream.

F. Supply Plenum:
   1. Integral supply plenum lined with 1" thick 3# density foil faced rigid board insulation to prevent condensation. Plenum includes a perforated diffuser plate the entire length of the hood to evenly distribute supply air.
G. Balancing Damper:
   1. Hood supply collar includes balancing damper with locking quadrant to regulate supply air flow.

H. Supply Inlet Fire damper
   1. Hood supply collar includes U.L. Listed 18 gauge steel construction fire damper as required per NFPA-96.

I. Hanger Brackets:
   1. Heavy gauge steel uni-strut channel hanger brackets with adjustable spring loaded rod couplings for 1/2" threaded rod.

J. Controls:
   1. Hood shall be provided with EMS demand control ventilation system controller mounted within integral hood utility cabinet.
   2. The EMS shall use variable frequency drives and temperature sensors to modulate the fans speed.
   3. The system controller shall modulate the fans speeds based on the temperature differential as measured in the ambient space and exhaust duct risers.
   4. The system shall include an LCD screen interface for operation of fans, hood lights, programmable schedule, Override function, Preparation Time mode, Cool Down mode, and diagnostics including VFD status.
      a. The LCD interface shall be shipped loose for field installation as indicated on the drawings.
   5. The system shall be provided with a space temperature sensor for field installation as indicated on the drawings.
   6. The system shall be provided with two duct temperature sensors to be field installed in the exhaust duct risers. The sensors shall be constructed of stainless steel.
   7. All factory wiring shall be color coded with as-built wiring diagrams installed inside the NEMA 1 enclosure.

K. Hood Lights:
   1. U.L. Listed for commercial cooking hood use, vapor proof LED type.
   2. Shatterproof, greaseproof and waterproof construction.
   3. Mounted one each three to four feet of canopy length and pre-wired to a junction box on top of the hood.

L. Stainless Steel Skirt:
   1. Stainless steel construction ceiling enclosure panels.

2.10 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS

   A. The installation of new wet chemical fire extinguishing systems shall comply with the following:
1. Factory Mutual Engineering And Research Corporation (FM) Approval Guide.
2. NFPA 17A -- Wet Chemical Extinguishing Systems.
5. NFPA 96 -- Ventilation Control and Fire Protection of Commercial Cooking Operations
7. UL 300 -- Fire Testing of Fire Extinguishing System for Protection of Restaurant Cooking Areas.

B. General:

1. Provide an automatic wet chemical fire extinguishing system for 100 percent coverage of the kitchen equipment area under the kitchen equipment hood, filter section and exhaust duct. Provide systems for protection of requiring protection by NFPA 96.
2. Consist of all components contained within the hood, including control heads, heat detectors, activator tubing in ½ inch conduit, pipe, nozzles and brackets.
3. System connected to new chemical cylinders and activation controls mounted above the ceiling.

C. Field Coordination

1. Take field measurements necessary for the design of the system. Submit full details of the system for review by the Architect before fabrication.
2. Include final check-out by a factory authorized technician.
3. Provide and install automatic gas shut-off valve to close upon activation of fire suppression system.

D. Products

1. Piping and accessories within the hood are stainless steel or chrome plated.
2. All other piping is galvanized steel, painted to match the adjacent surface, chrome or nickel plated or stainless steel or black steel painted to match the adjacent surface.
3. Exhaust hoods with grease extractors UL listed or FM approved are not required to have protection downstream of the grease extractors.

E. System Controls

1. System is mechanically actuated by fusible links and by remote manual actuation stations connected to the extinguishing system release mechanisms by stainless steel cables.
2. Arrange each system to automatically shut off the flow of fuel and electrical power to cooking appliances and to automatically actuate the building fire alarm fire alarm system.

F. Identification Signs

1. Provide red rigid plastic signs with engraved 1/4 inch high white lettering at each remote manual actuation station.
2. Sign legends shall be "Fire Extinguishing System" followed by a brief description of the equipment protected.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify inlet and outlet locations.
B. Verify ceiling and/or wall systems are ready for installation.

3.2 INSTALLATION
A. Install diffusers to ductwork with airtight connection.
B. Provide rigid elbows at inlet of round neck diffusers. **DO NOT CONNECT FLEXIBLE DUCT DIRECTLY TO DIFFUSER.**
C. Install balancing dampers on duct take-off to diffusers, grilles, and registers.
D. Install return air duct directly over return air grilles. Plenums on top of return air grilles not less than 6 inches before transition to return duct connection.
E. Paint visible portion of ductwork behind air outlets and inlets matte black.

3.3 INTERFACE WITH OTHER PRODUCTS
A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION – 23 37 00
SECTION 23 74 13 – PACKAGED MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged Rooftop Gas/DX Make-Up Air Units.
   2. Roof Mounting Curb and Base.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 270 – Sound and Rating of Outdoor Unitary Equipment.

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

C. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

D. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data, Submit the following:
   1. Indicate capacity of manufactured products and assemblies specific to this project.
   2. Indicate electrical service with electrical characteristics and connection requirements.
   3. Indicate dimensions, weights and duct connections of each unit.
1.4 CLOSEOUT SUBMITTALS

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

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

C. Manufacturer’s Installation Quality Check-Off form:
   1. Contractor to complete for each unit installed.
   2. Bind in folder, indicating project site. Submit with O&M data.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping
   skids and lifting lugs. Inspect for damage.

B. Protect units from weather and construction traffic by storing in dry, roofed location.

1.7 WARRANTY

A. Furnish one year manufacturer warranty for entire unit.

B. Provide ten year warranty on gas fired heat exchanger.

PART 2 - PRODUCTS

2.1 DIRECT FIRED MAKE-UP AIR UNITS

A. Manufacturers:
   2. Greenheck Corp.

B. Description:
1. Unit shall be tested in accordance with ANSI Z83.4a-2001 and shall bear the ETL label. Orientation shall be down discharge. Unit shall be factory assembled, tested and shipped as a complete packaged assembly for outdoor mounting, consisting of the following:
   a. Gas burner
   b. Complete DX Cooling System
   c. Centrifugal blower (forward curved, DWDI)
   d. Motor starter with thermal overload protection
   e. Motor and drive assembly
   f. Fuel burning and safety equipment
   g. Temperature control system
   h. Gas piping

C. Housing:

1. Unit shall be constructed of 20 gauge G-90 galvanized steel. The wall panels and roof shall be fabricated by double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked airtight with silicone caulk. The unit base shall be suitable for curb mount. Housing construction should be suitable for outdoor installation.
2. An observation port shall be located on the exterior of the unit for observation of the main flame and pilot flame. All controls, gas valves, modulating controls and electrical components shall be mounted within the burner vestibule.
3. The vestibule full-size door shall provide easy access to controls and gas train components. Blower door shall provide easy access to blower, motor and drives.
4. Internal rigid board 1 inch x 1.5 inch foil face insulation shall be installed on roof, walls and base of casing.

D. Base:

1. The base shall be constructed of galvanized steel. Base shall be structurally reinforced to accommodate the blower assembly and burner.

E. Blower:

1. Blower shall be forward curved, centrifugal Class-I or II (depending on application requirements, double width, double inlet, constructed of G-90 galvanized steel. Unit shall have heavy duty, solid steel shaft. Wheels shall be balanced in two planes in accordance with AMCA 204-96. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys. The blower assembly shall be isolated from the fan structure with vibration isolators.

F. Motor:

1. Motors shall be premium efficiency, heavy-duty ball bearing type and furnished at the scheduled voltage, phase and enclosure. Motor shall be Open Drip-Proof type.

G. DX Cooling System:

1. All cooling equipment should conform to local code requirements. All gas manifold components shall be piped and wired at the factory.
2. Components Shall Include:
a. 14 SEER minimum condenser  
b. Thermal Expansion Valve  
c. Filter/Dryer  
d. Hard Start Kit for Condenser  
e. Insulated Suction Lines  
f. Multiple Stages where required  
g. Pre Charged System  
h. R-410A Refrigerant

H. Safety Controls:
1. Motor starter with adjustable overloads  
2. Air-flow safety switch  
3. Electronic flame-safety relay  
4. High-temperature limit switch  
5. Man gas regulator  
6. Two safety shut-off valves  
7. Modulating-gas valve  
8. Burner  
9. Adjustable burner ON/OFF inlet air duct-stat to shut off burner when inlet air is sufficiently warm to maintain space temperature  
10. Non-fused disconnect  
11. High gas pressure switch  
12. Low gas pressure switch  
13. Proof of closure switch

I. Accessories:
1. Two-position motor operated inlet damper.  
2. 2 inch thick aluminum mesh coated filters.  
3. Fresh air inlet hood/filter combination.  
4. Roof curb: 12 inches high, constructed of 18 gauge aluminized steel as a completely welded assembly. Roof curb shall be continuous to support entire unit assembly.

J. Temperature Control System:
1. Controls shall be listed by ETL (UL 508A). The control enclosure shall be NEMA 1 rated and listed for installation inside of the exhaust hood utility cabinet. The control enclosure may be constructed of stainless steel.  
2. This unit shall be interlocked with kitchen hood exhaust and it shall energize to provide make-up air anytime the hood exhaust is in operation.

K. Electrical:
1. A single point electrical connection shall be supplied for fan module and DX cooling system. Motor starter shall be provided.  
   a. Separate 120V control circuit shall be provided in addition to 3 phase power. Factory mounted disconnect shall be installed to serve 120V circuit.  
2. Units shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire as required for proper operation. All factory mounted controls shall be
pre-wired to the unit control panel. A safety disconnect switch shall be standard and shall be sized according to the unit.

3. Unit shall be operated, tested and set at the factory using job-site conditions for electrical and gas input. All operating and safety controls shall be tested and set at the factory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level, regardless of roof slope.

D. Provide initial factory start-up, including routine servicing and check-out.

3.3 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters.

END OF SECTION – 23 74 13
SECTION 23 74 16.11 - PACKAGED GAS/ELECTRIC ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged rooftop air conditioning unit.
2. Roof curb.

B. Related Sections:

1. Section 230923 - Direct-Digital Control System for HVAC: Controls remote from unit.
2. Section 233300 - Air Duct Accessories: Flexible connections.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.

D. ASTM International:


E. National Fire Protection Association:

1.3 DEFINITIONS

A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.

B. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).

1.4 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Duct connections.
   6. Electrical requirements with electrical characteristics and connection requirements.
   7. Controls.
   8. Accessories.

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

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of controls installed remotely from units.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 QUALITY ASSURANCE

A. Cooling Capacity: Rate in accordance with ARI 210/240.

B. Sound Rating: Measure in accordance with ARI 270.

C. Insulation and adhesives: Meet requirements of NFPA 90A.

D. Outside Air Damper Leakage: Test in accordance with AMCA 500.
1.7 QUALIFICATIONS

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

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept units on site. Inspect for damage.

B. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.9 COORDINATION

A. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

1.10 WARRANTY

A. Furnish five-year manufacturer's warranty for compressors.

B. Furnish five-year manufacturer's warranty for heat exchangers.

1.11 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish one set of 2 inch pleated (60%) filters for each unit.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR CONDITIONING UNITS

A. Manufacturers:

1. Lennox.
2. Trane.

B. General:

1. Convertible discharge units
2. Minimum Efficiency ratings:
   a. 3, 4 and 5 ton: 14.0 SEER
   b. 6, 7-1/2, 8-1/2 ton: 11.0 EER
c. 12 ton: 10.8 EER

3. Factory assembled, single-piece, outdoor packaged unit, electrically-controlled heating and cooling unit utilizing a hermetic compressor for cooling duty, and gas combustion for heating duty.

4. Units are factory wired, fully charged with refrigerant charge (R-410a), and 100% run tested before leaving factory.

5. Cooling performance rated in accordance with ARI Standards 210/240 or 360 and 270.
   a. Unit capable of starting and running at 115 F ambient outdoor temperature, meeting maximum load criteria of ARI Standard 210/240 or 360.
   b. Compressor with standard control capable of operation down to 40 deg F ambient outdoor temperature.
      1) Wiring internal to unit colored and numbered.
      2) UL-tested and certified in accordance with ANSI Z21.47 Standards, UL 1995 and CSA No. 236-M90.

C. Unit Cabinet:

1. Constructed of zinc coated heavy gauge galvanized steel, coated with a baked enamel finish.
2. All panels insulated with minimum 1/2 inch thick foil faced glass fiber insulation. Unit base insulated with 1/2 inch 1 pound density closed cell insulation.
3. Unit top:
   a. One piece construction or seamed with double-hemmed and gasket sealed construction.
4. Unit base:
   a. For water integrity, unit base pan constructed of one piece material or with liquid tight welded seams. Duct penetrations have minimum 1 inch high curb built into base pan.
5. Hinged Access Doors:
6. Holes provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.

D. Fans:

1. Evaporator Fan:
   a. Fan wheel: steel double-inlet, forward-curved blades with corrosion-resistant finish.
   b. Fans are dynamically balanced.
   c. Direct drive with multi-speed motors for 3 thru 5 ton units.
   d. Belt drive with adjustable sheaves for 6 thru 10 ton units. Provide with adjustable idler arm assembly.
   e. Motor:
      1) Permanently lubricated with built-in overload protection.

2. Condenser Fan:
   a. Direct-driven propeller type, draw through configuration, vertical air discharge.
   b. Construction: aluminum blades riveted to corrosion resistant steel spiders, dynamically balanced.
   c. Motor:
1) Permanently lubricated with built-in overload protection.

3. Induced-draft blower:
   a. direct-driven, single inlet, forward-curved centrifugal type, made from steel with a corrosion-resistant finish, dynamically balanced.

E. Compressor:

   1. Hermetically sealed, direct drive, scroll type.
   2. Built in internal over current, over temperature protection as standard.
   3. Provide with centrifugal oil pump.
   4. Compressors resiliently mounted on neoprene isolators.

F. Refrigerant circuit:

   1. Provide with Thermal Expansion valves, service pressure ports, and refrigerant line filter driers.

G. Coils:

   1. Evaporator and condenser coils: aluminum plate fins mechanically bonded to copper tubes with all joints brazed.
   2. Tube sheet openings belled to prevent tube wear.
   3. Evaporator coil: full face active design.
   4. Evaporator tested at 250 psig; condenser coil tested to 400 psig.
   5. Double sloped condensate drain pan under evaporator section.

H. Heating Section:

   1. Induced-draft combustion type with energy saving direct-spark ignition system and redundant main gas valve.
   2. Tubular-section type constructed of a minimum of 20-gage steel coated with a nominal 1.2 mil aluminum-silicone alloy for corrosion resistance.
   3. Burners shall be of the in-shot type constructed of stainless steel.
   4. All gas piping shall enter the unit cabinet at a single location.

I. Controls and Safeties:

   1. Unit provided with self-contained low-voltage control circuit protected by an auto-reset device.
   2. Heating section provided with the following minimum protections:

      a. High-temperature limit switch.
      b. Induced-draft motor speed sensor.
      c. Flame rollout switch.
      d. Flame proving controls.

J. Filter Sections:

   1. Factory-installed, low velocity, throwaway 2 inch thick fiberglass filters of commercially available sizes.
K. Roof Curb:
   1. Roof curb designed to conform to NRCA Standards.
   2. Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.
   3. Allows for installing and securing ductwork to curb prior to mounting unit on the curb.
   4. Curbs configured so that the unit will be level when installed on the roof. Make necessary provisions when installing curb to allow for level installation.
      a. Refer to mechanical schedules for curb heights.

L. Outside air provisions:
   1. Units 3 and 4 tons:
      a. Motorized damper to allow for up to 50% outside air – manually set at installation.
   2. Units 5 tons and larger:
      a. Outdoor Economizer with 0-100 percent, fully modulating opposed blade dampers with electric actuator.
      b. Provide with minimum position setting device, preset linkage and wiring harness with plug.
      c. Fixed Dry bulb control.

M. Powered Exhaust (Where required in mechanical schedules)
   1. Direct driven propeller fan mounted at return air plenum.
   2. Field wired to unit power supply.

N. Condenser Coil Hail Guard Assembly:
   1. Close mesh design to prevent small hail from penetrating the screen.
   2. Stand off from the condenser coils by at least one inch.

O. Electrical Access with Disconnect Switch:
   1. Factory installed 3 pole molded case disconnect switch with provisions for through the base electrical connections.
   2. Disconnect switch installed inside unit with water tight enclosure with access through swinging door.
   3. Factory wired from switch to high voltage terminal block.
   4. Switch sized per NEC and UL.
   5. Switch UL/CSA agency recognized.
   6. Un-powered Convenience Outlet:
      a. Factory installed GFCI, 120 VAC, 2 plug convenience outlet.

P. Controls:
   1. Provide unit with conventional thermostat interface board for connection to third party control system.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

A. Roof Curb:

1. Assemble roof curb.
2. Install roof curb level.
3. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
4. Install gasket material between unit base and roof curb.

B. Connect units to supply and return ductwork with flexible connections. Refer to Section 233300.

C. Install a type L copper trap in the condensate connection of each cooling coil. Extend condensate drain to 18x18x6 galvanized steel drain pan.

D. Install components furnished loose for field mounting.

E. Install control wiring between unit and field installed accessories.

3.3 INSTALLATION - NATURAL GAS HEATING SECTION

A. Connect natural gas piping in accordance with NFPA 54.

B. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.

C. Install the following piping accessories on natural gas piping connections.

1. Shutoff Valve.
2. Dirt Leg.
3. Flexible Connection.

D. Install natural gas piping accessories above roof.

3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.
3.5 CLEANING
   A. Vacuum clean coils and inside of unit cabinet.
   B. Install new filters in units at Substantial Completion.

3.6 DEMONSTRATION
   A. Demonstrate unit operation and maintenance.

END OF SECTION - 23 74 16.11
SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fan coil unit.
   2. Condensing unit.

B. Related Sections:
   1. Section 232300 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
   4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. ASTM International:

D. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1.3 SUBMITTALS

A. Section 230000: Submittal procedures.

B. Product Data: Submit data indicating:
1. Cooling and heating capacities.
2. Dimensions.
3. Weights.
4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

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

D. Manufacturer's Field Reports: Submit start-up reports.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of controls installed remotely from units.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. Sound Rating: Measure in accordance with ARI 270.

B. Insulation and adhesives: Meet requirements of NFPA 90A.

1.6 QUALIFICATIONS

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

D. Protect units from weather and construction traffic by storing in dry, roofed location.
1.8 COORDINATION

A. Coordinate installation of condensing units with roof structure.

1.9 WARRANTY

A. Manufacturer’s warranty for a period of one (1) year from date of installation with additional compressor warranty for six (6) years from date of installation.

PART 2 - PRODUCTS

2.1 WALL MOUNTED INDOOR UNITS

A. Manufacturers:

1. Daikin.

B. General:

1. Unit shall be a wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. This compact design with finished white casing to be connected to outdoor unit. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

C. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

3. Both refrigerant lines shall be insulated from the outdoor unit.

4. Return air shall be through a resin net mold resistant filter.

5. The indoor units shall be equipped with a condensate pan.

6. The indoor units shall be equipped with a return air thermistor.

7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

8. The voltage range will be 253 volts maximum and 187 volts minimum.
D. Unit Cabinet:
   1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
   2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:
   1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
   2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
   3. The airflow rate shall be available in high and low settings.
   4. The fan motor shall be thermally protected.

F. Coil:
   1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   3. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design completely factory tested.
   4. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.
   5. A thermistor will be located on the liquid and gas line.
   6. A condensate pan shall be located in the unit.

G. Electrical:
   1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:
   1. Provide each system with hardwired programmable thermostat.

I. Condensate Lift Kit:
   1. Provide indoor units with Daikin model DACA-CP3-1 pump kit for field installation.

2.2 OUTDOOR UNITS

A. Manufacturer:
1. Daikin.

B. General:

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Daikin swing compressor, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separator, service ports and suction line accumulator.
2. Liquid and suction lines must be individually insulated between the outdoor and indoor units.
3. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
4. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
6. The outdoor unit shall allow for side-by-side installation with minimum spacing.
7. The following safety devices shall be included on the condensing unit; high pressure switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
8. To ensure the liquid refrigerant does not flash when supplying to the various indoor unit units, the circuit shall be provided with a sub-cooling feature.
9. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
10. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

C. Unit Cabinet:

1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

D. Fan:

1. The fan shall be a direct drive, propeller type fan.
2. The motor shall be inverter drive, permanently lubricated type bearings, inherent.
3. The fan shall be capable of operating in “silent operation” which lowers the outdoor fan speed in either cool, heat or auto modes.
4. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
5. Airflow shall be horizontal discharge through a “twisted” grill for optimum airflow and lower operating sound.

E. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.

F. Compressor:
1. The Daikin inverter scroll compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermatically sealed swing type.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be 14% to 100%.
5. The compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system.
7. The compressor shall be spring mounted to avoid the transmission of vibration.

G. Electrical:
1. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
2. The control voltage between the indoor and outdoor unit shall be 18VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Support indoor unit from structure as directed by manufacturer in strict accordance with manufacturer’s installation instructions.
B. Install outdoor unit on roof platform as detailed. Shim unit level and secure to platform. Install unit on neoprene pads.
C. Provide and install shop fabricated expanded metal hail screens to cover condenser coil.
D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
E. Install refrigerant lines as directed by the manufacturer. Insulate suction lines along their entire length. Secure refrigerant lines and provide proper support. Make connections to indoor and outdoor unit – check for leaks.

F. Provide condensate drain connection for cooling coils. Extend as indicated on the drawings to drain. Provide pipe supports from structure and slope down in direction of flow. Insulate condensate drain line.

G. Install wiring in accordance with manufacturer’s instructions.

H. Install remote controller in location shown. Terminate all control wiring.

I. Set DIP switches on units. Demonstrate to Owner/User. Coordinate settings with User’s requirements.

3.2 CLEANING
   A. Vacuum clean coils and inside of unit cabinet.

3.3 DEMONSTRATION
   A. Demonstrate complete system operation and maintenance.

END OF SECTION – 23 81 26
SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED WORK

A. Examine all Drawings, Specifications, and associated Contract documents and coordinate them with work described in this Division of the Specification.

1.2 DESCRIPTION OF WORK

A. The work covered by Division 26 of the Specifications includes the furnishing of all materials, labor, transportation, tools, permits and fees, and incidentals necessary for the complete installation of all electrical work required in the Contract Documents.

B. It is the intent of the Contract Documents to provide an installation complete in every respect.

C. All items noted, indicated, and called for herein and on the Drawings shall be furnished and installed by this Contractor unless noted to be furnished by others. These items may include wiring, conduit systems, electrical equipment, and other electrical systems required for a complete system.

D. In the event that additional or special construction is required, the Contractor is responsible for providing all material and equipment which are usually furnished with such construction in order to complete the installation, whether indicated or not.

E. The Contractor is advised to visit the premises and thoroughly familiarize himself with existing conditions including any conditions on which his work might depend. Advise the Architect of any discrepancy or conflict prior to bidding.

1.3 DRAWINGS AND SPECIFICATIONS

A. These Specifications are accompanied by Drawings and details of the installations indicating the locations of equipment, outlets, controls, circuits, and related items. The Drawings and these Specifications are complimentary to each other, comprising the Contract Documents, and what is required by one is as binding as if required by both. Where conflicts may occur between the Drawings and the Specifications, the most stringent interpretation of the design concept is binding unless the Engineer waives this provision.

B. If the Contractor deems it necessary to change or depart from indications, requirements, or similar instructions of the Drawings or Specifications, submit to the Architect or Engineer for review details of and reasons for the proposed departures. Do not make changes or departures without prior approval.

1.4 CODES, STANDARDS AND FEES

A. General code compliance:

1. In general, comply with the current editions of the standards issued by the following organizations or governing bodies:

a. General code requirements:

1) National Electrical Code (NEC) (NFPA 70).
3) International Fire Code (IFC).
4) Underwriters Laboratories (UL).

b. Manufacturer’s standards:

1) National Electrical Manufacturers Association (NEMA).
2) American National Standards Institute (ANSI).
3) Certified Ballast Manufacturers (CBM).

c. Governmental standards and codes:
   1) Occupational Safety and Health Acts (OSHA).
   2) Federal Americans with Disabilities Act (ADA).
   3) State of Texas Elimination of Architectural Barriers Act (Texas Civil Statutes).
   4) City of Amarillo and Canyon Electrical Codes and Ordinances.

d. The terms and conditions of services provided by the following utilities:
   1) Xcel Energy (Xcel).
   2) AT&T.
   3) Suddenlink.

e. Any other authorities that may have lawful jurisdiction pertaining to the work specified.

2. Refer to the individual Specification Sections for detailed references to applicable standards. Where specific codes or standards are listed individually in other sections of these Specifications, the intent is to call attention to the requirements of these particular codes or standards and not to imply that the previously listed codes or standards do not apply.

B. None of the terms or provisions of this Specification waive any of the rules, regulations, or requirements of authorities with standards governing the construction work. In any instance where these Specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these Specifications take precedence.

C. In case of direct conflict between applicable Codes and the Contract Documents, the Codes govern.

D. The Contractor is responsible for all permits, fees, and licenses required due to or because of this project. Include costs of all such permits or fees in the bid. No additional compensation will be made for any required inspection, permit, license, or fee.

1.5 SUPERVISION AND OBSERVATION OF THE WORK

A. Supervision of the work:
   1. Provide a competent foreman at the building site to receive instructions and to act for the Contractor.
   2. The Contractor is solely responsible for work methods, jobsite safety considerations, and contract compliance at the project site.
   3. The Engineer has no authority to exercise any control over work, health, or safety precautions. All such items are the Contractor’s sole responsibility.

B. Observation of the work:
   1. The Engineer or Engineer’s representative reserves the right to observe the work at any time.
   2. Give assistance, as may be required, to the Engineer or Engineer’s representative or observer during inspection of the work.
   3. The observation of the work and other professional activities of the Engineer shall not relieve the Contractor of his obligations, duties, and responsibilities including construction means, methods, sequences, techniques, or procedures necessary for performing, superintending, or coordinating all portions of the construction work.
   4. The presence of the Engineer or Engineer’s representative at the job site or his observance of the Contractor’s work does not relieve the Contractor of any safety or work related responsibilities.
5. The Engineer’s periodic inspections do not constitute a warranty by the Engineer, nor do they imply a fiduciary duty on the part of the Engineer to certify that the work is complete in all respects or performed completely in accordance with all Contract Documents. The responsibility for compliance with the Contract Documents rests with the Contractor.

1.6 REVISIONS TO THE WORK

A. All addendum and change order items are governed by the same terms and conditions as the Contractor’s initial contract with the Owner.

B. Expeditiously carry out, in a timely manner, authorized changes or recommendations made by appropriate persons.

C. Change orders:
   1. Refer to the General and Special Conditions for the appropriate manner for submitting any change orders.
   2. All proposed change orders shall be presented in written form to the Architect for acceptance or denial by the Owner.
   3. Contractor initiated change orders shall be formally made only after discussion with the Engineer regarding reasons for the anticipated change.
   4. Provide complete break-downs of costs in all change orders with details of material quantities, quantity costs, man-hours required, cost per man-hour, overhead, and profit clearly set out in the change order. Provide a clear indication of any overall cost increase or decrease.
   5. Minor changes in the work, which require little or no increase in the cost of construction and which will not require a change in the construction contract, do not require formal change orders. However, these changes must be approved by all parties concerned.
   6. Unless specifically authorized otherwise, the Contractor must present each proposed change order as the matter comes up and not present omnibus change orders at the completion of the project.

D. Replace or revise any materials or workmanship that are deemed unsatisfactory due to improper selection or placement of equipment or materials, or due to incomplete installation.

1.7 WARRANTY

A. General warranty: Guarantee all materials and workmanship for proper operation and service for a period of one year after the final acceptance of work.

B. Warranty work included furnishing both materials and labor to replace the defective items.

C. Extended warranty:
   1. Where noted in another Section or Division of the Specifications, such as for lighting fixture ballasts, extend warranty past twelve months to the time limit noted.
   2. Magnetic ballasts shall be warranted for a period of at least 2 years from time of acceptance.
   3. Electronic ballasts shall be warranted for a period of at least 5 years from time of acceptance.
   4. Surge protective devices shall be warranted for a period of at least 2 years from time of acceptance.
   5. Occupancy sensors shall be warranted for a period of at least 2 years from time of acceptance.
D. Lamps:
1. Lamps shall be warranted for the manufacturer’s standard published average lifetime, or the project one year warranty period, whichever is less.
2. Lamp lifetime shall be measured from the time of the Owner’s acceptance of the project and not from the time of first energization.
3. If lamps do not meet this lifetime criteria, they shall be replaced at the Contractor’s expense during the warranty period.
4. Where questions arise as to the actual “burn time” of the lamps, the Owner shall furnish to the Contractor estimates of the actual lamp burn time.
5. Replacement lamps shall be new and not drawn from the Owner’s spare stock.

1.8 TEMPORARY ELECTRICAL SERVICES

A. Division 26 is solely responsible for the installation and removal of temporary electrical service unless approved otherwise by the Architect or Engineer.

B. The installation and removal of temporary electrical service shall not be excluded from the contract.

C. Payment for costs of energy usage:
1. Metered utility electrical use (energy charges) for new buildings, whether received from temporary or permanent services, shall be paid for by the Contractor until the Owner accepts the building.
2. Division 16 shall not be responsible for paying for the metered utility energy charges unless agreed to with the other trades.

D. Scope of temporary electrical services required:
1. Provide reasonable and necessary power and lighting services for construction.
2. It is not the intention of these Specifications to require that electrical service be mandated for specific types of equipment (such as hoist, elevators, or pumps) that can be or have been served by other means.
3. Temporary lighting levels for construction:
   a. At least 20 footcandles, as measured on the floor or work surface.
   b. As uniform as practical given job conditions and layout of construction.
   c. Provide in areas and at such times as adequate natural light is not available during construction hours.
4. Receptacle layout, ground fault protection, grounding testing, and similar items must equal or exceed those prescribed by OSHA.
5. Any permanently installed receptacles used for temporary construction services shall be ground fault protected per NEC.
6. Refer to NEC Article 305 for additional requirements of temporary wiring systems.

E. Utilization of permanent lighting for construction services:
1. Clean fixtures used for temporary service during construction and bring up to new equipment condition.
2. Replace lamps which are utilized for temporary service during construction and have significant burn times with new lamps within five (5) days of final inspection or when directed by Architect.

F. Establishment of construction services:
1. Temporary construction services may include the installation of temporary utility transformers and services, use of portable generators, or other suitable means.
2. If utility construction services are required, the contractor is responsible for contacting the utility and paying for any costs associated with the establishment and removal of the construction service.
3. Utilize construction service until the permanent service is installed and available for use.
4. Site temporary facilities so that they do not conflict with permanent construction or remove as soon as practical when permanent construction moves into their area.

1.9 BUILDING CONSTRUCTION AND LAYOUT OF WORK

A. Consult all Drawings and Specifications to thoroughly familiarize oneself with the type and quality of construction to be provided on this project.

B. The electrical Drawings are diagrammatic in character. Installation details are subject to the requirements of structural and architectural conditions as well as code and ordinance provisions.

C. Plan the installation so that work will be concealed in walls, ceilings, chases and related portions of the building unless specifically noted or indicated to be exposed.

D. The location of electrical items is indicated approximately on the Electrical Drawings. These Drawings are not intended to give complete and exact details in regard to location of outlets, equipment, and other items. Exact locations are to be determined by actual measurements and equipment shop drawings. Symbols or notes for equipment starters, disconnects, and similar items are provided to alert the Contractor of the need for such equipment and are not to be construed to identify the exact placement of the required items.

E. Consult the Architectural Details to determine wall finishes and locations of wall mounted signs, boards, mirrors, and similar items to insure that electrical outlets do not interfere with wall finishes or materials attached to walls.

F. Any switch, receptacle, lighting fixture, outlet, junction box, panelboard, and similar type of equipment that interferes with existing or new finishes, conflicts with other equipment, or compromises the use of the facilities by the Owner, may be moved up to 10 feet without additional cost to the Owner, Architect, or Engineer.

G. Any overhead or underground mechanical, electrical, communication service of any nature damaged by the construction shall be restored to working condition during and after construction to the satisfaction of the Owner. The Owner will make every effort to assist the Contractor, but the location of services shall be the responsibility of the General Contractor and Electrical Contractor.

1.10 SUBMITTAL AND APPROVAL OF MATERIALS

A. Within a minimum of 30 days after the contract has been awarded, submit for approval complete data covering equipment and materials, which the Contractor proposes to furnish and for which submittal information is required. Consult the General, Supplementary General, and Special Conditions of the Contract Documents to determine if a faster response time than 30 days is required.

B. General submittal requirements:
   1. Before submitting shop drawings or any related material to the Engineer, Contractor shall:
      a. Thoroughly review safety practices, precautions, and programs for the construction process and determine if any proposed or indicated construction or sequences of construction will or may possibly cause undue hazards, fail to properly protect workers, or otherwise violate the letter or intent of applicable safety practices. Any such questions of compromise of safety shall be brought to the immediate attention of the Architect.
b. Review each submission for conformance with the means, methods, techniques, sequences, and operations of construction.

c. Coordinate all items to determine if the physical sizes of the submitted items are in accordance with the allowable sizes or dimensions as indicated on the Drawings and as called for on any dimensioned Architectural plans.

d. Approve each submittal prior to submission. Stamp or otherwise acknowledge that the submission has been reviewed and approved prior to submission.

e. Notify and document in the submittal index any deviation from specified materials.

f. Furnish complete, and as specified (both on the Drawings and in the Specifications), any minor or miscellaneous items not submitted for review. Otherwise, all items will be assumed to be furnished complete and as specified.

2. Submit data in three ring hard back binders sized for 8-1/2” X 11” enclosures. Larger format submittals, such as equipment layouts or special shop drawings, shall be edge bound and folded to fit 8-1/2” X 11” size and adequately attached with the submittal.

3. Submit all data at one time. Partial submittals may only be made for large projects and only with the prior approval of the Engineer.

4. The Engineer reserves the right to directly charge the Contractor for time and material costs, at standard hourly rates, if more than two (2) submittals of the same class or type of materials or equipment is required to obtain substitution approval.

5. The Engineer, Architect, and Owner will each retain one copy of each submittal. Provide sufficient additional copies for the Contractor’s use and the use of his suppliers.

C. Submittal documents:

1. Provide a cover sheet with the following information:
   a. Title of the submittal.
   b. Name and location of the building or project.
   c. Name of the entity making the submittal.
   d. Supply house(s) supplying the equipment.
   e. Date of the submittal.
   f. Space on cover sheet or associated area that can accept a submittal review stamp from the Engineer.

2. Follow the Specification format with each major category of equipment having its own manila divider referenced to the particular section of the Specifications. Provide a separate detailed listing included at the front of each section of the submittal listing each item by item as follows:
   PRODUCT SPECIFIED:  MFG. NAME AND NUMBER
   PRODUCT PROPOSED:  MFG. NAME AND NUMBER

   The detailed listing may be omitted for lighting fixtures if the subsequent catalogue cut sheets properly indicate all features of the lighting fixtures including type, complete catalogue number, ballasts, etc.

3. Equipment requiring submittal:
   a. Lighting fixture assemblies including submittal data for:
      1) Enclosures and housings.
      2) Photometrics reports.
      3) Lenses.
      4) Lamps.
5) Magnetic ballasts.
6) Electronic ballasts.
b. Panelboards, switchboard, motor control center, and transformers.
c. Disconnect and safety switches including the individual loads that they supply
d. Separately mounted starters and the loads that they control.
e. Contactors and photocell.
f. Fuses.
g. Metering enclosures.
h. Wiring devices and plates.
i. Floor boxes and covers.
j. Fire alarm system components.
k. Dimmer system components.
l. Occupancy sensors and systems.
m. Other special system components and equipment.

4. At the Engineer’s request, the following equipment and items must also be submitted:
a. Conduit, raceways, and fittings.
b. Wires and cables.
c. Boxes.

D. Submittal approval and review:
1. Submittals which are submitted in the manner outlined previously will be reviewed by the Engineer.
2. The Engineer will make a good faith effort to check and review the submittals during the normal course of business.
3. The Contractor shall notify the Engineer of any time constraints for equipment order placement, release, or similar issues that make or may make expeditious submittal approval required.
4. The Engineer’s approval and review process is provided under the following conditions:
a. Review of a manufacturer’s engineered systems or manufactured components, whose design is under the sole control of the manufacturer, will not be made.
b. The Engineer may require additional documentation, tests, information, or other data in order to finalize the approval process.
c. If additional documentation or information is not provided, is provided in an unsatisfactory manner, or is not provided in a timely manner, the affected materials and equipment shall be furnished as specified, complete in all respects.
d. The approval review will be performed only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents.
e. No attempt to check quantities of equipment will be made. The Contractor is solely responsible for providing the correct numbers of all items.
f. Modifications or comments made on or attached to the shop drawings or submittals do not relieve the Contractor from compliance with the requirements of the Drawings and Specifications.
g. Approval of a specific item does not necessarily convey approval of the assembly of which the item is a component.
1.11 SUBSTITUTIONS

A. General requirements:
   1. The listing of product manufacturers, catalog numbers, etc., on the Drawings and in the various sections of the Specifications is generally intended to establish a standard of quality for those products.
   2. Selection of items or equipment specified or indicated to be furnished is based on engineering judgment regarding application, physical sizes or shapes, dimensions, performance levels, efficiencies, maintenance conditions, colors, materials available, comparison to similar products, and other attributes and conditions that may not be obvious or apparent to those wishing to obtain approval for substitution.

B. Prior approvals:
   1. All manufacturers listed on the Drawings or in a particular Section of the Specifications as “Approved Manufacturers” are pre-approved to furnish the specified products only provided that their offered products meet the Specifications.
   2. Manufacturers not listed on the Drawings or in a particular Section of the Specification, as “Approved Manufacturers” require prior approval to furnish their products on the project.
   3. Where the Specifications refer to “or equal,” “Engineer approved equal,” or similar language, the intent of the Specifications is to require approval of substituted items prior to bidding and not after bidding.
   4. The Engineer may waive the prior approval requirement due to unusual project conditions, such as lack of qualified vendors, if requested.
   5. Substitution requests must be received by the Engineer at least 10 working days before bid date.
   6. Requests must include a detailed listing of all products with adequate data sheets for the Engineer to make detailed comparison with specified products.
   7. Unless special or modified construction is required, all substituted products must be standard manufactured items normally produced by the manufacturers requesting substitution.
   8. Unsuccessful attempts to provide adequate or acceptable samples will cause the proposed substitution to be rejected.
   9. It is the responsibility of the Contractor to review all items he wishes to substitute with the Engineer to determine if such substitutions meet the requirements and intent of the Specifications and the Drawings.
   10. It is the right of the Engineer to review any and all substitutions and to reject any items that the Engineer deems unacceptable.

C. The Contractor may request substitution materials or methods (unless such substitution is prohibited on the Drawings or in the Specifications), which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it is understood that the Contractor:
   1. Has investigated the substitute product and determined that it has all the same accessories and is equal to or superior in all respects to the product specified.
   2. Has investigated the substitute product and determined that while it is not superior to the product specified, it offers other features or options that the Engineer may consider to be advantageous to the product or equipment specified.
   3. Has coordinated the installation of the equipment, which he proposes to substitute with all trades and includes the costs for any changes required for the substitution.
   4. Waives any and all claims for additional costs related to the substitution.
5. Will secure authorization for substitution from the Engineer prior to ordering and installing the substitute.

D. Uniformity of equipment selection and application:
1. Categories of equipment require that uniformity across the equipment line be maintained and providing related products from more than one manufacturer of similar equipment will not meet the intent of these Specifications.
2. Unless noted otherwise, the following categories of items shall each be furnished by a single manufacturer:
   a. Switchboard, panelboards, and disconnect switches.
   b. Starters and contactors.
   c. Lighting fixture lamps.
   d. Fuses.
   e. Electronic linear fluorescent ballasts.
   f. Wiring devices and plates.
3. The Contractor is advised that lighting fixtures may require uniformity in areas such as number of louvers per fixtures, louver finish, downlight cone appearance, aperture size, or similar constraints.
4. The Engineer reserves the right to disqualify a manufacturer from supplying a portion of the items in a category if the manufacturer cannot furnish all items in a category or if the proposed items in the category do not meet uniformity or appearance conditions.

1.12 RECORD DRAWINGS
A. Keep a set of Drawings on the job, noting all changes made in these Drawings in connection with the final installation including dimensioned locations of all lines and utilities outside the building.
B. Turn over to the Architect, for delivery to the Owner, at least one clean, neatly marked set of blue line drawings showing “as-installed” work.

1.13 FIRE SEALING
A. All electrical penetrations through fire rated walls, floors, and ceilings shall be fire sealed to prevent the propagation of smoke and fire, regardless of whether they are enclosed in raceways or are free-wired.
B. Provide fire sealing in all locations required by applicable Codes.
C. Utilize materials suitable for the intended service.
D. See Section 26 05 33 (Raceways and Boxes) for fire sealing requirements and methods. Fire sealing shall be provided for both raceway and free-wired low voltage cabling through firewalls or fire barriers.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS
A. Standards for materials and equipment are minimum standards. Materials and equipment selected for use in the project may be required to exceed the minimum testing and labeling standards.
B. Minimum standards shall include the following (where standards for the particular material or equipment are available):
   1. National Electrical Code (NEC) requirements.
   2. Underwriters Laboratories (UL).
C. Labels and marks:
1. Individual components must bear the UL Component Recognition marking (backwards UR symbol) for items such as wiring, power supplies, switches, etc.
2. Assembled equipment must bear the UL mark (UL inside of a circle) based on published UL Standards for Safety.

D. Material and equipment testing:
1. Materials must be tested to applicable UL standards and shall have passed the respective test requirements.
2. The listing and/or labeling will be accepted as evidence that the materials or equipment conform to the applicable standards of that testing organization.

2.2 STANDARDS PRODUCTS
A. Materials and equipment are generally selected from standard products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications.
B. Custom designed products or product modifications are project specific and require adherence to the design conditions.

2.3 CONDITION OF MATERIALS AND APPURTENANCES
A. All conduit, conductors, fixtures, panelboards, switchboard, and other material systems must be new unless otherwise specified.
B. Replace any equipment injured or damaged in transit from the factory, during delivery to premises, while in storage on premises, while being erected and installed, or while being tested, until time of final completion, without extra cost to Owner.

PART 3 – EXECUTION
3.1 SPACE AND EQUIPMENT ARRANGEMENT
A. Install equipment to allow ready access to parts requiring operation or service without disassembly of other equipment.
B. Maintain working clearances as required by the NEC as follows:
   1. NEC working clearances shall be maintained as directed by Article 110.
   2. Working clearances required by the NEC are minimum standards. Provided additional clearance where needed or where indicated on the Drawings.
   3. Required working clearances shall be maintained for at least the following general categories of equipment:
      a. Disconnect switches, safety switches, starters, and contactors (front of equipment).
      b. Panelboards (normally front of equipment).
      c. Switchboard (normally front of equipment, but may include sides).
      d. Enclosed transformer housing access plates (normally front of transformer).
      e. HVAC and mechanical unit electrical access plates.
   4. Contact Engineer for questions on interpretations of clearance requirements.
C. Provide adequate clear width for equipment maintenance. Minimum width is 30" for equipment operating at 600V or less.
D. Protect equipment against construction and weather damage.
E. Any large piece of apparatus, which is too large to permit access through completed building openings shall be brought to the job and placed in the space before the enclosing structure is completed.
3.2 CUTTING AND PATCHING
A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation or repair of any electrical work, such cutting must be approved by the Architect.
B. The Contractor is not permitted to cut or modify any structural members without the written permission of the Architect.

3.3 CLEANING
A. Keep the premises free from accumulations of waste material or rubbish.
B. At completion of the job, remove all tools, scaffolding, and surplus materials and leave the area “broom clean”.

3.4 SLEEVES AND PENETRATIONS
A. Install conduit sleeves in a timely manner so as not to impede other trades. Moisture seal sleeves in a manner approved by the Architect.
B. Install pitch pans and flashing for roof penetrations that are compatible with the roofing systems. Roof penetrations are subject to the approval of the Architect.

3.5 SUPPORTS
A. Provide all supporting equipment necessary to erect the electrical system. This support may consist of, but is not limited to, items such as channels, structural members, ceiling support wires, brackets, anchors, inserts, and similar items.
B. Install supports in a safe and structurally sound manner paying attention to the mounting surface and structural characteristics. Any supporting methods in question must be called to the attention of the Architect or Engineer for resolution.

3.6 EQUIPMENT AND HOUSEKEEPING PADS
A. Each piece of floor-mounted equipment, such as switchboards, generators, motor control centers, and transformers, requires a neat cement-finished, structural grade concrete base.
B. Equipment located on upper floors not subject to water exposure may be installed directly on concrete floors provide rubber vibration pads between each of the transformer mounting feet and the floor surface.
C. Minimum requirements for equipment or housekeeping pads:
   1. Pour bases not less than 4” high. Provide additional height if required by the Drawings or to match extensions of existing pads.
   2. Tool finish pads and provide a ¾” chamfer along all exposed tops of sides.
   3. Reinforce pad with #10 10X10 welded wire mesh placed in the center of the pad. Reinforce pad with #4 reinforcing bars laid 12: on center both ways and placed in the center of the pad. Keep bars at least 3” from the sides of the pads for generator.
   4. Pin pads to floor with short lengths of re-bar extending at least 3” into the floor and at least 3” into the pad.
   5. Pin pads to any adjacent existing concrete structures.
   6. Minimum 28-day compressive strength of pad is 3,000 psi.

3.7 ELECTRIC CONTROL WIRING OF HVAC MOTORS AND MOTOR-OPERATED EQUIPMENT
A. Control wiring of HVAC motors and motor-operated equipment:
   1. General requirements
a. It is the intent of these specifications to provide a clear delineation of responsibilities for the providing of electrical control wiring.
b. Divisions 25 and 26 shall jointly coordinate with each other to insure that all control wiring is provided as described.
c. All required items shall be furnished under the contract, with responsibilities of specific items as described hereafter, or in Division 25 Specifications.
d. While these specifications indicate the contract responsibilities of the various Divisions, they do not prevent job-site mutually agreed upon revisions or modifications to these responsibilities provided that ultimate contract responsibilities are retained as described in the Specifications.

2. Responsibilities of Division 25 (Mechanical).
   a. Furnish and set in place, ready for electrical connection, all HVAC motors and motor-operated HVAC equipment unless specifically noted otherwise.
   b. Provide and set in place all HVAC control devices, such as relays, thermostats, electrically operated valves, control panels, and related items.
   c. Provide and install all HVAC and energy management system interconnecting control wiring as follows:
      1) Install wiring between the equipment and its associated control point.
      2) Install all control wiring in conduit unless noted otherwise. Minimum conduit size is ½”, except where connections at indoor equipment terminals allow use of 3/8” flex.
      3) Install all HVAC control wiring in accordance with Section 26 05 19 and 26 05 33.
      4) Coordinate with Division 25 to obtain wiring diagrams for the installation of the control wiring.
      5) Where conductor sizes and numbers to various control connections are indicted on the Drawings, these are for reference only and require coordination between Divisions 25 and 26 to insure that all wiring is correct according to the selected equipment manufacturer’s recommendations. Provide additional wiring or conductor sizes as required to satisfy specified functions or to connect to equipment furnished.

B. Control wiring for other systems:
   1. Provide and install control, actuation, and associated interconnecting control wiring for fire alarm system auxiliary components, including connections to electrically operated smoke dampers, HVAC smoke control systems, air handling unit starters, and similar equipment.

3.8 DISPOSAL
   A. Items not retained by the Owner of Contractor for their use shall be disposed of in an official sanitary landfill or delivered to the local City refuse collection system, provided such items are suitable for ordinary disposal.
   B. Disposal shall conform to the EPA “Universal Waste Rule.”

3.9 CONNECTION OF EQUIPMENT
   A. Carefully examine the Drawings and Specifications for details regarding the construction of the electrical systems.
B. Verify voltage, phase, ampacity, and connection requirements of all electrically operated equipment furnished by other trades. If the actual equipment furnished varies materially from that intended for connection, notify the Architect or Engineer for resolution of connection details.

C. Verify rotation of all motor operated equipment or other equipment that is rotation sensitive. Rotation shall be verified prior to voltage application to equipment unless approved otherwise.

D. Carefully examine all documentation furnished with electrical equipment prior to installing connections and operating equipment.

E. Any equipment requiring certification, testing, calibration, or similar work by others prior to normal operation shall have such work performed by certified individuals or manufacturers prior to operation of the equipment.

3.10 WARRANTY DOCUMENTATION
A. Deliver all warranty documentation to the Owner after acceptance of the building by the Owner.

B. Documentation shall include sufficient information including manufacturer, local representative, type and model numbers of equipment, date of Owner’s acceptance, length of warranty period, and similar data.

3.11 IDENTIFICATION AND LABELING
A. Properly mark disconnect switches, panelboards, switchboards, special purpose device plates, designated receptacles, junction boxes, outlet boxes, etc., to identify their service or designation. Refer to section 26 05 53.

3.12 CONDITIONS OF EQUIPMENT AT FINAL ACCEPTANCE
A. Prior to the time of acceptance, inspect all installed systems to assure that all construction is complete and premises are clean.

B. Insure that all lighting fixtures are operating and that lenses and reflectors are free of dust, debris, and fingerprints.

C. Lighting fixture lamps must be new or do not have significantly reduced lifetimes.

D. Switchboard and panelboards must have all conductors neatly formed, laced and made-up tight.

E. Equipment enclosures and plates shall be cleaned of stray paint, dust, grease and visible fingerprints.

F. All circuit directories and labels are in place.

G. All scratched surfaces are touched-up with paint matching original paint type and color. Where paint cannot be matched, repaint the entire surface in a color and manner approved by the Architect.

H. Equipment lock keys shall be delivered to the Owner and not left in enclosures.

I. Spare lamps and spare ballasts have been delivered to Owner and a signed receipt obtained.

END OF SECTION – 26 05 00
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY
A. Section includes building wire and cable rated 600 volts or less and wiring connectors and connections.

1.2 REFERENCES
A. International Electrical Testing Association:

1.3 SUBMITTALS
A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Product Data: Submit for building wire and each cable assembly type.

1.4 CLOSEOUT SUBMITTALS
A. Section 01 70 00 – Contract Closeout: Requirements for submittals.
B. Project Record Documents: Record actual locations of components and circuits.

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

1.6 FIELD MEASUREMENTS
A. Verify field measurements are as indicated on Drawings.

PART 2 PRODUCTS

2.1 BUILDING WIRE
A. Manufacturers:
   1. Southwire.
   2. Encore.
   3. Essex Group Inc.
   4. Triangle.
   5. Capital.
   8. United Copper Industries (THHN/THWN only).
   9. Substitutions: Section 01 60 00 – Material and Equipment.
B. Product Description: Single conductor insulated wire.
   1. Soft drawn annealed copper based upon 98% conductivity.
   2. Tinned or untinned in accordance with established standards for the type of insulation around the conductors.
   3. Uniform in circular cross-section and continuous without splice except at junction or outlet boxes.
C. Insulation: 600 volt rating; thermoplastic material rated 75 degrees C.
   1. Permanent marking approximately every two feet indicating conductor size, voltage, and temperature rating.
   2. Insulation type for general use conductors: THHN/THWN.
D. Service entrance, feeder, and branch circuit conductor construction standards:
1. Sized per the American Wire Gauge.
2. Solid per ASTM B3 for #12 AWG and smaller power and lighting conductors.
3. Solid or Class B stranded (per ASTM B8) for #10 AWG.
4. Class B stranded per ASTM B8 for conductors larger than #10 AWG.
5. Single conductor, 600V insulation, UL listed.
6. Install only in approved raceways or conduit.
7. Not smaller than #12 AWG.

2.2 EQUIPMENT CONNECTION CORDS:
A. Provide where indicated on the Drawings for equipment cords, suspended drop cord, and similar locations as follows:
1. Fine stranded copper conductor construction for enhanced flexibility.
2. Each phase, neutral, and grounding conductors individually insulated with a black round insulating jacket.
3. Minimum 90 degree C temperature rating in wet or dry locations.
4. Minimum size #14 AWG for 15A applications and minimum #12 AWG for 20A applications unless noted otherwise.
5. 600V cord voltage rating.
6. NEC type SO (extra hard usage thermoset rubber insulated oil resistant jacket) or extra-flexible type SOOW (extra hard usage thermoset rubber insulated oil resistant jacket and insulation, weather resistant) where noted.
7. Complete with cord, plug and matching receptacle.

2.3 WIRING CONNECTORS
A. Conductor splice connectors smaller than #6 AWG ("wire nuts"):  
   1. Dry and damp locations:
      a. Scotch.
      b. Burndy.
      c. Buchanan.
      d. 3M.
      e. Wago Corp.
   2. Wet locations:
      a. King Technology (silicon filled).
      b. Buchanan (epoxy filled).
B. Conductor splice connectors #6 AWG and larger (power distribution blocks):
   1. Square D.
   2. Bussmann.
   3. NSI Industries.
C. Tape:
   1. 3M.
   2. Plymouth/Bishop.
D. Wire connector requirements:
   1. UL Listed.
   2. 600VAC insulation rating.
   3. #8 AWG and smaller dry location joints made with insulated compression spring “wire nuts”. Other connection methods, such as Wago push-wire connectors, may also be used.
   4. #8 AWG and smaller wet location joints made with insulated silicon or epoxy filled waterproof compression spring “wire nuts”.
2.4 PULLING COMPOUNDS
A. Pulling Compounds:
   1. Ideal.
   2. 3M.
   3. American Polywater.
B. Wire connector requirements:
   1. UL Listed.
   2. Wax based.
   3. Compatible with cable jacket. Do not use lubricant that will damage the conductor’s insulation.

PART 3 EXECUTION
3.1 EXAMINATION
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Coordination and project conditions.
B. Verify interior of building has been protected from weather.
C. Verify mechanical work likely to damage wire and cable has been completed.
D. Verify raceway installation is complete and supported.
3.2 PREPARATION
A. Completely and thoroughly swab raceway before installing wire.
3.3 INSTALLATION
A. Route wire and cable to meet Project conditions.
B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
D. Pulling conductors into conduits and raceways:
   1. Pull conductors into raceway at same time.
   2. Do not exceed the wire or cable manufacturer’s recommended pulling tension when pulling wires or cables in raceways.
   3. Provide adequate lubricant when necessary.
E. Joints and splices:
   1. Service entrance and feeder conductors:
      a. Install service entrance and feeder conductors as a continuous run the entire length without splicing.
      b. Do not splice in pull boxes, even if pull boxes are indicated on the Drawings or required by the NEC, unless specifically approved by the Engineer.
   2. Branch circuit splices:
      a. Install only where accessible in junction boxes, pull boxes, equipment enclosures, or similar locations.
      b. Materials used must meet UL standards.
      c. 600VAC insulation ratings.
      d. Wire nut type joints and splices:
         1) Dry location with conductors #8 AWG and smaller with insulated compression spring “wire nuts”.

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2) Wet location joints with conductors #8 AWG and smaller with insulated silicon filled waterproof compression spring “wire nuts”.

3) Wet location conductor epoxy filled “wire nuts” shall be made with enough slack to allow enough lead length for a minimum of one removal and re-termination.

e. Tape any exposed conductors with multiple layers of insulating friction tape.

F. Properly tag and identify all branch circuit conductors as follows:
   1. Use vinyl cloth wrap around for dry locations.
   2. Use heat shrink type wrap for wet locations.
   3. Indicate circuit number for wiring terminated in panelboards.
   4. Indicate circuit number and panel designation for wiring terminated on application device.

G. Leave at least 6 inch conductor tails at each outlet for the installation of devices or fixtures.

H. Install equipment and drop cords on equipment furnished by others including appliances, circulating pumps, and similar equipment.

3.4 WIRE COLOR

A. General
   1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
      a. Black and red for single phase circuits at 120/240 volts.
      b. Black, red, and blue for circuits at 120/208 volts single or three phase.
      c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
   2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
      a. Black and red for single phase circuits at 120/240 volts.
      b. Black, red, and blue for circuits at 120/208 volts single or three phase.
      c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:
   1. For 6 AWG and smaller: Green.
   2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.
   3. Isolated grounding conductors green with orange tracer.

3.5 BRANCH CIRCUIT SIZING

A. Minimum conductor size is #12 AWG for all circuits at a nominal voltage of 120VAC or greater.

B. Requirements for increased conductor sizing:
1. Where conductor sizes to mechanical equipment, panelboards, or similar equipment are upsized from their NEC minimums due to voltage drop considerations, the particular size indicated on the Drawings shall be maintained throughout from the circuit source to its load side connection.

2. Where branch circuit conductor sizes of general use receptacle circuits are upsized from #12 AWG due to voltage drop considerations, the larger size shall be maintained from the circuit source to the last junction box in the circuit run provided the final receptacle connection is 20 feet or less in length from the last junction box.

3. Where branch circuit conductor sizes of lighting fixture circuits are upsized from #12 AWG due to voltage drop considerations, the larger size shall be maintained from the circuit source to the last junction box in the circuit run, provided that:
   a. Where taps to interior lighting fixtures are made from interior above-ceiling junction boxes, the conductor size may be reduced to #12 AWG if the taps are 10 feet or less in length.
   b. Where interior lighting fixtures are field tandem wired or the bodies of fixtures are used as branch circuit raceways, the upsized conductor shall be maintained throughout the circuit.
   c. Where taps in exterior lighting fixtures are made in pole bases and run inside the pole to the luminaire, the taps may be reduced to #12 AWG provided this conductor size does not exceed 12 amps. For greater loads, upsize to #10 AWG or larger, as required.

C. Lighting Circuits:
   1. All exit or emergency lighting circuits: Minimum #10 AWG.
   2. 120V interior lighting circuits over 120 feet in total length: Minimum #10 AWG.
   3. 277V interior lighting circuits over 200 feet in total length: Minimum #10 AWG.
   4. 208V, 277V and 480 V exterior building lighting circuits: Minimum #12 AWG or as sized on the Drawings.
   5. Total circuit length is defined as the total distance from the power source to the last lighting fixture on the circuit.

D. Power and receptacle circuits:
   1. 120V receptacle circuits over 120 feet in total length: Minimum #10 AWG.
   2. 208V power circuits sized as noted.
   3. 277V and 480 V power circuits sized as noted.
   4. Total circuit length is defined as the total distance from the power source to the last power connection on the circuit.

END OF SECTION – 26 05 19
SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rod electrodes.
   2. Wire.
   3. Mechanical connectors.
   4. Exothermic connections.

B. Related Sections:
   1. Section 03 30 00 – Cast in Place Concrete: Bonding or welding bars when reinforcing steel is used for electrodes.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
   1. Metal underground water pipe.
   2. Metal building frame.
   3. Concrete-encased electrode.
   4. Rod electrode.

1.4 SUBMITTALS

A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Product Data: Submit data on grounding electrodes and connections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Contract Closeout: Requirements for submittals.
B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.6 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Material and Equipment: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 COORDINATION
A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS
2.1 ROD ELECTRODES
A. Manufacturers:
   1. Copperweld, Inc.
   2. Erico, Inc.
   3. Substitutions: Section 01 60 00 – Material and Equipment.

B. Product Description:
   1. Material: Copper-clad steel
   2. Service Entrance Grounds: 3/4 inch diameter and 10 feet in length.
   3. Supplemental Ground Rods: 1/2 inch diameter and 6 feet in length.
   4. Pole Base Grounds: 1/2 inch diameter and 6 feet in length.
   5. Connector: Connector for exothermic welded connection.

2.2 WIRE
A. Material: Stranded copper.

B. Foundation Electrodes: 4 AWG.

C. Grounding Electrode Conductor: Copper conductor bare or insulated.

D. Bonding Conductor: Copper conductor bare or insulated.

2.3 MECHANICAL CONNECTORS
A. Manufacturers:
   1. Erico, Inc.
   2. Substitutions: Section 01 60 00 – Material and Equipment.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS
A. Manufacturers:
   1. Cadweld, Erico, Inc.
   2. Substitutions: Section 01 60 00 – Material and Equipment.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.
PART 3 EXECUTION

3.1 EXAMINATION
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Verification of existing conditions before starting work.
B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION
A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.3 GENERAL INSTALLATION REQUIREMENTS
A. Install in accordance with IEEE 142 and NEC Article 250.
B. Install rod electrodes at locations as indicated on Drawings.
C. Install grounding and bonding conductors concealed from view.
D. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

3.4 RACEWAY GROUNDING CONDUCTORS
A. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
B. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panel boards with installed number 12 conductor to grounding bus.

3.5 MAIN GROUNDING ELECTRODE CONDUCTOR AND BONDING JUMPER
A. Provide at the service entrance as follows:
   1. Ground and grounding conductors shall be copper only.
   2. Size ground and grounding conductors per NEC Article 250 or larger as so indicated on the Drawings.
   3. Grounding conductors located inside equipment enclosure may be either bare copper splice plates(s) or insulated copper conductor(s).
   4. Grounding conductor(s) run outside of the service equipment shall be insulated copper conductor(s) enclosed by conduit.
   5. Attachment to grounding electrodes shall be as required by NEC 250-70.
   6. Grounding electrode conductors shall be installed as required by NEC 250-24 between the main service equipment ground bar and the grounding electrode(s) external to the service equipment. Maximum size of the grounding electrode conductor shall be #4/0 unless noted otherwise.
   7. The main bonding jumper(s) between the service equipment solid neutral bar and its ground bar shall be sized as per NEC 250-28 and Table 250-66. The size of the bonding jumper(s) shall be at least 12.5% of the combined conductor sizes of any service entrance phase. Where provided by the equipment manufacturers, bonding plates (or screws for small installations) are acceptable in lieu of Contractor installed bonding jumpers.
B. Run the grounding electrode conductor from the service entrance equipment ground bar to the following locations. The listing of the grounding electrodes is in order of preference from best to least effective:

1. The building main cold water service metal pipe within 5 feet of where the cold water enters the building. Attachment may be through a flange bolt head lug, a suitable clamp or U-bolt connector fitted around the pipe circumference, a terminal lug exothermically welded to the metal pipe, or other method approved by the Engineer. Where dielectric unions exist in the cold water metal pipe outside the building, provide properly sized bonding shunt strap around the water meter and all dielectric unions in the water pipe. Bonding straps to water service meters may be omitted where prohibited by the local Authority Having Jurisdiction.

2. A main structural steel member of the building where the building construction is either framed steel columns and joists or is supported by steel rigid frames.

3. Concrete slab:
   a. Bond to reinforcing steel where at least 20 feet of 1/2 inch of larger diameter re-bar is accessible prior to pour. Bond to the rebar installed near the bottom of a footing of slab.
   b. Where no slab reinforcing steel is readily available for grounding connection, provide as follows:
      1) Connection to a steel cage for a poured pier whose bottom is at least 6 feet below grade.
      2) Where no reinforcing steel is readily available in the slab pour, a bare copper conductor, minimum #2 AWG and at least 20 feet in length, may be substituted for the reinforcing steel.
      3) The concrete encased reinforcing steel shall not comprise the sole grounding electrode conductor but instead shall be supplemental only.
      4) Where the building is supported by poured concrete columns and joists, bonds to additional rebar other than in slab is not required.

4. Driven ground rod(s). Service entrance ground rods shall be at least 10 feet in length with the top of the rod driven at least 6 inches below grade. Where rods are not able to be driven vertically due to existing conditions (such as sub-surface rock), install at an angle provided the rod end(s) are below the frost line. Where multiple ground rods are used, space ground rods at least 20 feet apart horizontally.

5. Do not bond to metallic gas piping.

6. Do not bond to plastic piping.

C. Where the grounding electrode conductor(s) extend(s) from the service entrance equipment, install as follows:

1. Conduit protection:
   a. Protect with EMT, IMC or rigid steel conduit where exposed above grade.
   b. Single grounding conductors installed in metallic conduit shall have grounding bushings and jumpers between the conduit and the conductor at the termination end where the conduit stops prior to the connection to the termination of the conductor.

2. Conduit protection is not required where installed below grade or below slabs.

3.6 GROUNDING CONNECTIONS

A. Where noted on the Drawings, provide compression or exothermic weld connections to the building structural steel, ground grids, or to grounding rods.
B. Either Burndy “HyGround” compression connection system or Cadweld exothermic welding system may be used for connection of copper conductors to copper conductors, or for connection of copper conductors to steel components.

C. Follow manufacturer’s guidelines for installing all components of the system.

3.7 FIELD QUALITY CONTROL

A. Test the main building grounding system for ground resistance per Section 26 05 90.

B. Perform ground resistance testing in accordance with IEEE 142.

C. Perform continuity testing in accordance with IEEE 142.

D. If resistance is greater than 5 ohms to ground, provide the following as required:
   1. Additional ground rods spaced a minimum of 20 feet apart.
   2. Modifications to the area surrounding the rods as follows:
      a. Concrete encasement of rods.
      b. Encasement of rods in material such as Erico GEM (Ground Enhancement Material) low resistivity material.
      c. The addition of bentonite (“driller’s mud”) to surround ground rods.
      d. Sodium chloride (salt) or magnesium sulfate installed in a trench approximately 18 inches away from the rod(s) and approximately 12 inches deep. Provide approximately 50 pounds of material per rod.

3. Manufactured cylindrical tube assemblies, such as Lyncole XIT Systems, with the following characteristics:
   a. Straight tubes 10 feet long, 2 inch nominal diameter, constructed of copper and filled with metallic salts. Salts shall dissolve to form an electrolytic solution that leaches into the adjacent soil to lower the ground resistance.
   b. A copper stranded cable connection to the remainder of the grounding system.
   c. Install tubes per the manufacturer’s recommendations in a shaft filled with bentonite or similar material.

END OF SECTION – 26 05 26
SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Conduit supports.
   2. Formed steel channel.
   4. Sleeves.
   5. Mechanical sleeve seals.
   6. Firestopping relating to electrical work.
   7. Firestopping accessories.
   8. Equipment bases and supports.

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.

1.2 REFERENCES

A. ASTM International:

B. FM Global:

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   5. UL - Fire Resistance Directory.

E. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1.5 PERFORMANCE REQUIREMENTS
A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS
A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
F. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.
G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE
A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
1.8 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 – Material and Equipment: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS
A. Section 01 60 00 – Material and Equipment: Environmental conditions affecting products on site.
B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
D. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS
2.1 CONDUIT SUPPORTS
A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
D. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
E. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL
A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS
A. Product Description: Mounting hole and screw closure.

2.4 SLEEVES
A. Sleeves for conduit Through Fire Rated and Fire Resistant Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
B. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 FIRESTOPPING
A. Manufacturers:
1. Dow Corning Corp.
2. Hilti Corp.
3. Substitutions: Section 01 60 00 – Material and Equipment

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B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

PART 3 EXECUTION

3.1 EXAMINATION
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Verification of existing conditions before starting work.
B. Verify openings are ready to receive sleeves.
C. Verify openings are ready to receive firestopping.

3.2 PREPARATION
A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
B. Remove incompatible materials affecting bond.
C. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS
A. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide precast inserts , expansion anchors and preset inserts.
   2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
   3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
   5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
   7. Wood Elements: Provide wood screws.
B. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.
D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
E. Install multiple conduit runs on common hangers.
F. Supports:
   1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
   2. Install surface mounted cabinets and panelboards with minimum of four anchors.
   3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.

3.4 INSTALLATION - FIRESTOPPING
A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS
A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

3.6 INSTALLATION - SLEEVES
A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
C. Set sleeves in position in forms. Provide reinforcing around sleeves.
D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

3.7 FIELD QUALITY CONTROL
A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING
A. Section 01 70 00 – Contract Closeout: Requirements for cleaning.
B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK
A. Section 01 70 00 – Contract Closeout: Requirements for protecting finished Work.
B. Protect adjacent surfaces from damage by material installation.

END OF SECTION – 26 05 29
PART 1 GENERAL

1.1 SUMMARY
A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
B. Related Sections:
   1. Section 26 27 26 – Wiring Devices.

1.2 REFERENCES
A. American National Standards Institute:
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
   2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
   3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
   5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 DESIGN REQUIREMENTS
A. Minimum Raceway Size: 1/2 inch unless otherwise specified.

1.4 SUBMITTALS
A. Section 01 30 00 - Submittals: Submittal procedures.
B. Product Data: Submit for the following:
   1. Flexible metal conduit.
   2. Liquidtight flexible metal conduit.
   3. Nonmetallic conduit.
   4. Flexible nonmetallic conduit.
   5. Nonmetallic tubing.
   6. Raceway fittings.
   7. Conduit bodies.
   8. Surface raceway.
   9. Wireway.
   10. Pull and junction boxes.
C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
1.5 DELIVERY, STORAGE, AND HANDLING
A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
B. Protect PVC conduit from sunlight.

1.6 COORDINATION
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Coordination and project conditions.
B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS
2.1 RIGID METAL CONDUIT
A. Manufacturers:
1. LTV Steel Tubular Products.
2. Allied Tube and Conduit.
B. Product Description:
1. Usage restrictions per NEC.
2. Used for:
   a. Above-grade service entrance and panel feeder runs.
   b. Runs in any areas subject to damage.
   c. Below grade raceways only where completely protected against corrosion.
   d. Wet or damp locations such as carwash or detail wash bay areas.
   e. Hazardous locations such as Class I, Division II environments.
3. Hot dipped galvanized low carbon strip steel with threads galvanized after cutting.
4. Fittings:
   a. All joints made with threaded couplings with 3/4" taper per foot dies installed wrench tight.
   b. Provide unions in lieu of couplings where required due to installation space or for final attachment of rigid conduit runs.
   c. Straight runs of conduit may utilize factory installed couplings (such as Allied “quick coupling”) instead of standard separate couplings.
   d. Set-screw type fittings are prohibited.
5. Slab or below grade installations:
   a. Use only where protected with an exterior corrosion protective layer.
   b. Coating may be field or factory applied.
   c. Factory applied coating requirements:
      1) Permanently fused to galvanized steel surface. Coatings that require the galvanized surface to be compromised prior to application of the coating are not acceptable.
      2) Smooth and continuous.
      3) Comply with NEMA RN1 and applicable ASTM standards for immersion in boiling water and application of humidity and acetone.
      4) Exterior coating:
         a) Field strippable.
b) Nominal 40 mil thickness of polyvinyl chloride (PVC).
c) Applied after the surface has been primed to receive the coating.

5) Interior coating:
a) Permanently coated.
b) Nominal 2 mil thickness of polyurethane.
c) Resistant to abrasion from pulling of conductors through conduit.

d) Use for ells or bends in rigid PVC conduit runs where pulling conductors into the conduit may damage or pull through plastic ells (see Part 3—Execution).

6. Coated rigid steel:
   a. Clean the steel surfaces of grease, oil, or other contaminants and prime for coating application.
   b. Add a 40 mil PVC plastic coating, free of blisters, bubbles, and pinholes, permanently fused to the entire exterior surface except for the threads. Coating adhesion properties shall be greater than the coating itself.
   c. Include an interior conduit coating of polyurethane for internal corrosion resistance.
   d. Clear polyurethane coating of factory threads.
   e. Couplings and fittings:
      1) Similar internal and external coatings as conduit.
      2) Flexible square-cut PVC skirts or sleeves extending at least one pipe diameter (or 2”, whichever is less) to completely seal the conduit system.
      3) Couplings require longitudinal ribs to allow use of installation tolls without damaging the coating.
   f. Comply with:
      1) ANSI C80.1.
      2) UL Standard #6.
      3) NEMA Standard 5.19.
   g. Provide touch-up compound for field treatment of scars or tears.

2.2 FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. Alflex.

B. Product Description:
   1. Usage restrictions:
      a. As per NEC Article 348.
      b. Flexible metallic conduit shall not be used as the general wiring system.
      c. Flexible metallic conduit shall not be used to “daisy-chain” branch circuit connections to recessed lighting fixtures except for inaccessible ceiling locations where approved by the Engineer.
      d. The Engineer shall be consulted on all questions regarding the use of flexible conduit and shall interpret the intent of the Specifications regarding the locations for which flexible conduit is allowed.
   2. Approved for general use in the following situations or locations:
      a. Vibration isolation for all interior dry location motor operated equipment such as fan powered boxes, unit heaters, and exhaust fans where the connected horsepower is less than 3/4HP.
b. Intervering of millwork and cabinets for feeds to receptacles, outlet boxes, and under cabinet low profile lighting fixtures.

c. Final whip connections to recessed interior lighting fixtures, smoke detectors, and similar equipment installed in accessible ceiling tiles that can be removed for maintenance or accessibility to the ceiling space.

d. Locations where equipment, ductwork, structure, or other hindrance makes it impractical or impossible to install straight or offset tubing or conduit. This provision does not provide for the use of flexible conduit where improper prior planning or delay in conduit installation make the location subsequently inconvenient for the use of straight or offset runs of conduit or tubing.

3. The use of flexible conduit in old work is extended to include installation of conduits fished in existing walls or other special or unusual situations approved by the Engineer.

4. Use of 3/8” flexible conduit in lieu of 1/2” trade size:
   a. Local Code restrictions prohibiting the use of 3/8” flexible conduit take precedence over NEC allowed use of 3/8” flex conduit.
   b. Provided local Code allows, the minimum flexible conduit size may be reduced for 1/2” to 3/8” where installed for any of the following conditions:
      1) Final whip connections to recessed single circuit and non-split-wired interior lighting fixtures mounting only in accessible ceilings.
      2) Connections to equipment with motors rated less than 1/6HP, motorized fire dampers, and similar equipment.
      3) Final connections to mechanical system controls, where raceways for mechanical controls are installed under Division 16.
   c. Additional restrictions effecting use and installation of 3/8” flex:
      1) Conduit must not contain more than 3 #12AWG or smaller insulated conductors.
      2) Conduit may serve no more than one light fixture.
      3) Length of flex is limited to 6 feet.
      4) Restrictions of NEC 350-10 are met.

5. Constructed of interlocking galvanized steel.

6. Used with fittings specifically approved for use with flex.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. Alflex.

B. Product Description:
   1. Usage restrictions per NEC.
   2. Used for:
      a. Final connections to vibration-producing equipment such as motors rated 3/4HP or more.
      b. Final connections to all exterior motorized equipment.
      c. Final connections to dry-type transformers.
   3. Constructed with a sunlight resistant non-metallic jacket over an inner flexible metallic core.
   4. Conduit without an inner metallic core (all plastic construction) is prohibited.
   5. Used with water-tight fittings approved for use with liquid-tight conduit.
6. Generally limited to six foot lengths.
7. Internal grounding conductor required for all lengths.

2.4 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. LTV Steel Tubular Products.
   2. Allied Tube and Conduit.

B. Product Description:
   1. Usage restrictions per NEC.
   2. Used for above-grade wiring only. EMT is not permitted in slabs or below grade.
   3. Used to enclose:
      a. General use above-grade wiring lighting, receptacle and equipment branch circuit conductors.
      b. General equipment feeds.
      c. Fire alarm and related wiring or cabling.
      d. Control wiring.
      e. Similar types of wiring unless noted otherwise in the specifications or on the Drawings.
   4. Galvanized mild strip steel with interior UL approved coating.
   5. Fittings:
      a. The following types of fittings, couplings, and connectors may be used:
         1) Die-cast non-insulated zinc compression type.
         2) Steel non-insulated compression type.
         3) [Conduits trade size 1-1/4” and smaller may have set screw fittings where used in dry interior locations only if the circuit contains a separate grounding conductor].
      b. The following types of fittings, couplings, and connectors are prohibited:
         1) Expanded conduit ends with factory pre-installed set-screw attachments.
         2) Indentor type.
         3) Set-screw type.

2.5 NONMETALLIC RIGID CONDUIT (PVC)

A. Manufacturers:
   1. Carlon Electrical Products.
   2. Can-Tex.

B. Product Description:
   1. Usage restrictions per NEC Article 352
   2. General requirements:
      a. Polyvinyl chloride compound.
      b. Schedule 40-wall thickness.
      c. Flame retardant type.
      d. Resistant to bending and cracking.
      e. UV resistant.
   3. Used for horizontal runs of underslab or underground conduits. Vertical risers and all ells installed below grade must be rigid steel installed as noted previously.
   4. No above ground installation.
   5. Couplings and fitting designed for permanent glued connection to the conduit.
2.6 INTERIOR OUTLET AND JUNCTION BOXES

A. Manufacturers:
   1. Steel City.
   2. Raco.
   3. Appleton.

B. Standard interior outlet boxes for connection to concealed conduit raceways, or for exposed surface mounted conduit raceways in mechanical spaces, electrical rooms, and similar non-public areas:
   1. General requirements:
      a. Of proper size and shape for conduits and conductors entering them.
      b. UL and NEC listed for their application.
      c. Constructed of code gauge steel.
      d. Galvanized or plated.
      e. Complete with conduit knockouts (boxes 4” square and smaller).
   2. A minimum of 1-1/2” deep unless the following conditions are met:
      a. Construction requires a smaller depth box.
      b. Engineer specifically approves the use of such shallow boxes.
      c. Depth is not reduced below 1-1/4”.
   3. Box construction:
      a. Formed (drawn) one piece, for single gang boxes.
      b. Formed (drawn) one piece or stamped and welded for double gang boxes.
      c. Formed (drawn), stamped and welded, or sectional type for boxes greater than 2 gang.
      d. Masonry type stamped and welded boxes (with continuous overlapping device screw attachment trim) may be used where recessed in concrete or concrete block (CMU) wall construction.
   4. Box size:
      a. 4” square for up to two devices and solid ganged boxes for over two devices.
      b. Single gang “handy boxes” may be used for device boxes in limited areas (such cabinet work) only with the Engineer’s permission. Do not use bevel corner boxes.
      c. 4-11/16” square boxes for specific devices (such as fire alarm equipment) where required. Consult with manufacturer to determine use and location of special boxes.
   5. Include steel partitions between box sections where required by operating voltage between switches greater than 300V.

C. Standard interior outlet boxes for connection to surface mounted two piece raceway systems:
   1. Stamped enamel painted steel.
   2. Of proper size and shape for surface raceways and conductors entering them.
   3. UL and NEC listed for their application.
   4. A minimum of 1-1/2” deep unless a shallower device box is approved.
   5. Single gang unless used for two devices.

D. Interior junction boxes mounted above the ceiling line for connection and distribution of branch circuit wiring to receptacles, lighting fixtures, and small motor loads shall be of the same type as standard 4” square outlet boxes except that they shall have flat steel covers.
2.7 CAST BOXES

A. Manufacturers:
   2. Appleton.

B. Where specified on the Drawings or required for surface mounted exterior or wet interior locations, provide cast outlet boxes.

C. Cast outlet box standards:
   1. Threaded hub type with drilled mounting lugs.
   2. Constructed of ferrous (malleable iron) alloy.
   3. Equal to Crouse-Hinds “Condulet” or Appleton “Unilet” type. Fixture outlet boxes equal to type VFX or GRF type; wiring device outlet boxes equal to type FS or FD.
   4. Provide with plugs for all unused openings, gaskets, and covers compatible with the function of the box.
   5. Where required to be coated for corrosion resistance, provide as follows:
      a. Permanently fused to galvanized surface. Coatings that require the galvanized surface to be compromised prior to application of the coating are not acceptable.
      b. Smooth and continuous.
      c. Comply with NEMA RN1 and applicable ASTM standards for immersion in boiling water and application of humidity and acetone.
      d. Exterior coating:
         1) Field strippable.
         2) Nominal 40-mil thickness of polyvinyl chloride (PVC).
         3) Applied after the surface has been primed to receive the coating.
      e. Interior coating:
         1) Permanently coated.
         2) Nominal 2-mil thickness of polyurethane.
         3) Resistant to abrasion from pulling of conductors through conduit.

2.8 PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Hoffman.
   2. Wiegmann.
   3. Milbank.

B. Install:
   1. Where noted on the Drawings.
   2. Where the total number of bends exceeds 360 degrees.
   3. At other locations required by the NEC.

C. Use boxes constructed of code gauge steel with standard size knockouts or suitable for field drilling.

D. Provide junction or pull boxes required by the Drawings or by codes larger than the standard 4” square where required.

2.9 EXTERIOR GRADE PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Strongwell Quazite.
2. Newbasis.
3. Carson.

B. Provide where required for termination and intermediate pulling access.

C. General requirements:
   1. Polymer cast concrete construction reinforced with fiberglass. Plastic construction is not acceptable.
   2. Designed for flush grade mounting.
   3. Solid wall construction without knockouts unless approved otherwise.
   4. Load ratings:
      a. General Duty UL Tier 5 for grassy and pedestrian traffic areas.
      b. Heavy Duty UL Tier 10 for sidewalks, driveways, and similar areas accessible to vehicular traffic.
   5. Lid:
      a. Single or two-piece.
      b. Attached with stainless recessed head bolts.
      c. Logo as directed, molded into top of lid.
   6. Bottom:
      a. Provide bottom in box where noted.
      b. Provide open bottom if not noted.
   7. See Drawings for sizes required.

2.10 FIRE SEALING REQUIREMENTS

A. All electrical penetrations through fire rated walls, floors, and ceilings shall be fire sealed to prevent the propagation of smoke and fire, regardless of whether they are enclosed by a raceway or not.

B. Provide fire sealing in all locations required by applicable Codes.

C. Utilize materials suitable for the intended service.

D. Fire sealing shall be provided for both raceway and free-wired low voltage cabling through firewalls or fire barriers.

E. Generally required UL ratings:
   1. Floors:
      a. Utilize FA rating for concrete floors less than 5 inches thick.
      b. Utilize FB rating for concrete floors more than 5 inches thick.
      c. Utilize FC for wood framed floors.
   2. Walls:
      a. Utilize WL rating for framed walls.
      b. Utilize WJ rating for concrete or masonry walls less than 8 inches thick
      c. Utilize WK ratings for concrete or masonry walls more than 8 inches thick.

F. Putties and sealants:
   1. Utilize for openings of less than 6 inches in diameter.
   2. Generally preferred method for sealing conduit penetrations through walls, ceilings, and floors.
   3. May be manufactured in caulk tubes, sticks, buckets, or similar manner to allow easy field insertion for fire stopping.
   4. Communication wiring and similar seals must remain permanently soft to allow reuse and re-entry into the sealed opening. Seals for permanent conduit penetrations may become hard after installation.
5. Do not use materials that give off toxic fumes when curing.
6. UL listed for the same rating as the wall the raceway penetrates (typically 1 or 2 hours).

G. Pipe wrap:
1. Utilize for conduit penetrations of walls, floors, and ceilings.
2. May be used instead of putties and sealants where approved by the Engineer.
3. Intumescent type that expands upon being heated.

H. Floor-to-floor conduit sleeves:
1. Provide rigid steel conduit sleeves where installed for upper wood or precast concrete tee floors.
2. Provide fire stop assembly for cast-in-place applications where above grade concrete floors are poured in place on site. Assembly requirements:
   a. Plastic sleeve with integral rubber gasket and intumescent ring of fire stopping material to provide both fire and smoke sealing.
   b. Top plug to exclude concrete during pouring of slab and dust and dirt after installation is completed.
   c. Suitable for replacement of conduit once installed without replacement of assembly.
   d. Suitable for use in floors between 2.5” and 6” of thickness.
   e. Resistance to normal temperatures up to 100 deg. C.
   f. Equal to Hilti CP 680 series.

2.11 CORROSION PROTECTIVE TAPE
A. General requirements:
1. Use for any metallic conduit installed in concrete or below grade.
2. Pressure sensitive PVC based type suitable for direct burial applications.
3. Impact resistant
4. Resistant to moisture, acids, salt, and alkales.
B. Equal to Scotch #50 or #51.

PART 3 EXECUTION
3.1 EXAMINATION
A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 FIRE SEALING REQUIREMENTS
A. Install fire sealing in all locations required by applicable Codes.
B. Fire sealing shall be installed for all raceway and sleeve penetrations of fire rated walls, ceilings, or floors above grade.
C. Fire sealing shall consist of fire rated putty, sealants, boards, poured or sprayed materials, pillows, or sheets of fire sealing material of required sizes and quantities to completely and effectively seal the associated fire barriers.
D. Wall penetrations of conduit shall generally be sealed with putty or caulk type sealant. Thoroughly seal penetration to avoid any air spaces around the wall penetrations.
E. Floor penetrations shall be sealed as follows:
   1. For wood floors and pre-cast steel concrete tees:
      a. Install rigid steel nipple through concrete floor. Stub both above and below floor line approximately 1 inch.
b. Securely attach nipple with pipe clamps or other suitable method to prevent nipple from shifting.

c. Pack between nipple and concrete opening with ceramic fiber or mineral wool for areas not requiring fire-stopping putty.

d. Install fire-stopping putty at top and bottom of penetration. Thickness shall be as recommended by manufacturer.

2. For cast-in-place concrete floor and concrete floors above metal decks with total floor thickness between 2.5” and 6.0” with dimensions of sleeves up to 4” in diameter.

a. Provide pre-manufactured firestop assembly instead of field fabrication method noted previously.

b. Assembly shall be Hilti #CP 680 series or other approved by the Engineer.

c. For total concrete construction:
   1) Attach bottom flange to bottom floor form with top of shaft above top of concrete pour.
   2) Close all openings with temporary plugs.
   3) Support assembly prior to pour to prevent movement.
   4) After floor is poured, cut off top of assembly flush with floor line and re-insert top plug.

d. For concrete topping slab installed on top of metal decking:
   1) Cut circular hole through decking and install metal deck adapter for assembly.
   2) Attach bottom flange of assembly to deck adapter and to screw bottom flange to deck. Place with top of assembly shaft above top of concrete pour.
   3) Close all openings with temporary plugs.
   4) Support assembly prior to pour to prevent movement.
   5) After floor is poured, cut off top of assembly flush with floor line and re-insert top plug.

F. Install all fire seal materials in accordance with manufacturer’s recommendations and NEC Article 300-21.

3.3 INSTALLATION- RACEWAY

A. Install all wiring in NEC approved raceways (unless specifically approved otherwise) sized as shown on the Drawings, or, if not sized on the Drawings, in accordance with NEC conduit fill tables.

B. Install raceway systems in a neat, straight, and workmanlike manner complete with all J-boxes and pull boxes as necessary or noted on plans.

C. Raceway general installation notes:
   1. All raceways are to be concealed unless noted or approved otherwise.
   2. Run concealed conduits as follows:
      a. Straight and parallel to building lines where installed in walls and above ceiling lines.
      b. In a direct line (unless interferences with other trades prevent) where installed under slabs or below grade.
      c. Do not run conduit horizontally in concrete block (CMU) walls, whether cells are filled or unfilled. Conduits must run vertically inside the CMU cells and be fed from overhead or underground, as appropriate.
   3. Exposed or surface raceways:
a. Difficulty in installing concealed conduit in existing or new construction is not in itself reason for installing surface raceways in lieu of concealed conduit.
b. Surface raceways shall generally be installed only in the following locations:
   1) Existing mechanical or boiler rooms.
   2) New outlets on existing solid masonry walls.
   3) Raceway is installed on the roof.
c. Install only at right angles to the building lines.
d. Conceal the appearance as best as possible even if this requires additional materials or longer routes. Homerun for outlet boxes on interior or exterior walls shall generally be run:
   1) From the outlet box down to accessible floor or tunnel space.
   2) From the outlet box to the room corner and then up to the accessible ceiling space.
   3) Do not run homeruns vertically from each outlet box.
e. Confirm the exact routing of any exposed raceways in the field with the A/E prior to roughing in.
4. Do not install wiring in exit stairwells except for that wiring associated with the stairwell itself (such as lighting or ADA communication systems).

D. Mechanical details of conduit and raceway installation:
1. Make all cuts squarely, ram after cutting, and butt conduits solidly into fittings.
2. All conduit and raceway systems must be mechanically continuous and installed complete before conductors are pulled.
3. Bend conduit with approved bending devices. Remove and replace deformed or damaged conduit.
4. Temporarily plug opening if conductors are not immediately installed in the raceway. Install plugs to exclude plaster or other foreign materials.
5. Treat field cut rigid steel conduit threads subject to moisture with paint-on or spray-on galvanizing equal to “Z.R.C. Cold Galvanizing Compound.”

E. When a metallic conduit enters an enclosure, provide an insulated throat connector and or an insulating bushing where the conduit contains conductors sized #4AWG or larger.

F. Do not run conduit or raceway adjacent to steam piping or hot vent piping unless authorization is provided.

G. Conductor sets:
1. Run feeders and service entrance conductor sets in individual conduits enclosing the associated phase, neutral, and grounding conductors for each set.
2. Run branch circuits generally in individual conduits. When branch circuits run in common directions or serve loads within common areas, the conductors may be combined as follows (grounding conductors are not counted in the total) where THHN/THWN conductors are used:
   a. Lighting circuits: Maximum of 6 #10AWG or smaller current carrying conductors in a single conduit.
   b. Receptacle circuits: Maximum of 9 #10AWG or smaller current carrying conductors in a single conduit.
3. Install conductor sets sized #8AWG and larger in individual conduits unless noted otherwise on the Drawings.

H. Sleeves:
1. Install where noted on the Drawings.
2. Provide for conduit entrances into exterior building walls below grade as follows:
a. Provide steel conduit sleeves, cutouts, chases or knockouts for passage of the raceways through the exterior wall(s).

b. Sleeves or knockouts shall be of adequate size to allow for reasonable settlement or movement of the raceway or building wall without damage to the enclosed conduits and wiring.

c. Completely seal all sleeves, chases, or knockouts to prevent moisture from entering basement areas or from migrating under footings.

d. Steel sleeves significantly larger than the enclosed conduit shall have a steel plate welded to the exterior of the sleeve to properly close the wall opening prior to waterproofing.

e. Consult the Engineer for determination of specific problem resolution which may include special construction.

3.4 INSTALLATION - UNDERGROUND RACEWAY

A. Carefully plan excavations for electrical systems and utilities in advance, paying particular attention to other utilities in the project area, both existing and new. Use hand and/or machine excavation cautiously to prevent damage to installed systems. The Contractor is responsible for repairing all damages caused as a result of excavation.

B. Standard conduit depths:

1. Slightly less than 60” deep for utility primary cables and conduits where ditching is provided by the Contractor.

2. Minimum of 36” below grade outside of the building lines for service entrance and feeder circuits.

3. Minimum of 24” below grade outside of the building lines for branch circuit conduits.

4. Below concrete building slabs:

a. Conduits installed under sidewalks, driveways, porches, and similar areas outside of the main building slab shall maintain the minimum depths listed above.

b. Conduit installed under the main building slab:

1) Do not install horizontal conduit runs in the slab itself.

2) Place conduit in sand cushion region below the building slab or place in the lower soil below the sand cushion.

3) Conduits placed in the lower soil shall have their surrounding ditch area filled with compacted sand with the bottom of the conduit placed at least 1” above the bottom of the ditch soil.

4) Adjust conduit depth so there is adequate room to turn up risers so that risers are vertical after passing through the top surface of the slab.

C. Ditch backfill:

1. Backfill with “flowable fill”:

a. Flowable fill shall contain Portland cement, water, fly ash, and fine aggregate.

b. Portland cement:

1) Mix shall contain a minimum of 3.5 sacks of Portland cement per cubic yard of fill.

2) Type I or type II conforming to ASTM C150 or ASTM C595.

c. Fly ash shall conform to ASTM C618 Class C or Class F. Fly ash may be eliminated only with written approval of the Engineer.

d. Batching and mixing shall conform to ASTM C94. Place with chutes, conveyors, or pumps.
e. Flowable fill shall “flow” with little head or mounding, with a slump of approximately 10” to 11”.

f. 28-day compressive strength shall be no more than 100 psi and no less than 75 psi.

g. Depth of flowable fill:
   1) Asphalted areas: Entire ditch depth except for within 7.5” of final grade.
   2) Grassy areas: Entire ditch depth except for within 12” of final grade.

D. Tracer wire:
1. Provide and install in conduit ditches for spare or unused conduits.
2. Install one #12AWG solid copper THHN/THWN insulated conductor in the ditch with the conduit.
3. Temporarily attach the tracer wire to the outer top surface of the conduit to keep the tracer wire from falling off of the conduit and into the ditch prior to backfilling. Utilize electrical tape, duct tape, or similar material for attachment of tracer wire.
4. Stub up tracer wire above grade on each end of conduit run as the conduit penetrates grade level. Provide loop of wire at each end to allow for future easy attachment of tracer equipment. Attach wire loops to sides of conduit.
5. Internal pull wire may not be substituted for tracer wire.
6. Tracer wire is required outside of the building slab perimeter for non-metallic conduits only under the following conditions:
   a. Empty service entrance and feeder non-metallic conduits installed without conductors and in a direction other than that of other service entrance of feeder conduits (spare or empty conduits run with active conduits do not require tracer wires).
   b. Active or inactive conduits for fiber optic cables.
   c. Service entrance, feeder, or branch circuit conduit stub-outs for future use.

E. Ditch marking tape:
1. Install in the ditch where utility or service entrance conduits are buried outside the building perimeter.
2. Tape is not required for exterior branch circuit ditches.
3. Install approximately 6” to 12” below final grade.
4. Tape requirements:
   a. Equal to 6 ply extra stretch “Terra-Tape 540” manufactured by Reef Industries, Inc.
   b. Nominally 6” wide.
   c. Yellow or red background with black block letters continuously printed with the statement “Caution Electric Line Buried Below” or similar acceptable wording.

3.5 INSTALLATION- PVC RACEWAY

A. Joints:
1. Thoroughly clean conduit and fitting or coupling prior to application of glue.
2. Utilize solvent type glue compound, which will provide a watertight permanent joint by welding both PVC surfaces together.
3. Do not use aerosol or spray-on joint compound.

B. Bends and offsets:
1. Make any PVC field offsets with a hot box bender specifically approved for the purpose.
2. PVC offsets of less than 45 degrees may be field or factory made.
3. Install factory PVC bend where angle of bend is 45 degrees or more.
4. Provide rigid steel or IMC factory ell or offset in conduit run, instead of PVC, where:
   a. Conduits 2” trade size or larger.
   b. Length of run exceeds 125 ft.
   c. Ropes larger than ¼” diameter are used for pulling conductors.
   d. Any location where the installation of the conductors may pull through the interior wall of PVC elbows or offsets.

C. Transition to the type of metallic conduit used above grade or above slab as the PVC conduit passes through the grade or slab.

D. Protection of steel fittings, couplings, elbows, and offsets utilized below grade in PVC conduit runs:
   1. Protect metallic conduit and fittings with either factory-applied coating or field applied coating.
   2. Coatings or fitting skirts shall extend past the metallic conduit or fittings onto the PVC conduit run to make a watertight seal.
   3. Field applied tape coatings:
      a. Overall coating must be a minimum of 20 mils thickness.
      b. Provide at least one half-lapped layer of Scotch #50 (10 mil) tape or one layer of Scotch #51 (20 mil) tape with overlapped edges.
      c. Prime conduit with Scotch Pipe Primer (or equal) prior to application of tape.

3.6 INSTALLATION- HDPE RACEWAY

A. Lay the conduit in the ditch as straight as possible, taking care to avoid “snaking” of conduit.

B. Conduit shall be installed complete, end-to-end, without joints in the HDPE run. If conduit installed is too short, replace with single continuous run.

C. Take precautions to avoid deforming the internal diameter of the conduit. Any conduit which is kinked or has excess “ovaling” shall be removed and replaced.

D. Provide couplers where transitioning from HDPE to PVC or steel conduit. Coupler installation:
   1. Thoroughly clean conduit and fitting or coupling prior to application of couplers
   2. Prepare cut conduit ends by beveling the outside edge of the conduit prior to inserting into the coupler.
   3. Remove any stray burrs or conduit shavings with a deburring tool.
   4. Install coupler onto conduits at the correct docking depth. Tighten stainless steel bands to provide a watertight joint.

E. Transition to the type of metallic conduit used above grade or above slab before the HDPE conduit passes through the grade or slab. HDPE may be run complete without transition only where the conduit terminates in a poured concrete base (such as a pole base).

3.7 GENERAL INSTALLATION – BOXES

A. Refer to the Drawings for the general location of boxes and outlets.

B. Switch boxes near doors:
   1. Install close to trim when located by doors.
2. Place wall switch outlets at door locations on the lock side of the door. If no usable wall space adjacent to the lock side jamb is available, place switch outlets on the wall against which the door swings and in a location accessible after the door is fully opened.

C. Boxes required by code due to conduit bends are generally not indicated on the Drawings.

D. The Contractor shall familiarize himself with the details of all rooms, spaces, and construction requirements so that the installation of outlets and other electrical equipment shall not interfere with work of other trades or render the outlets or equipment inaccessible for maintenance or repair.

E. Any outlet, box, or related item may be relocated within 10 feet of its indicated location without additional cost to others.

F. General Requirements:
1. Close unused openings with knock-out closures.
2. Properly support to prevent movement.
3. Reduced in size if necessary when indicated to be installed in window mullions or other areas requiring narrower or smaller boxes. Substitutions require the Engineer’s approval.

3.8 INSTALLATION – WALL OUTLET BOXES
A. Offset to reduce sound transmission between rooms.

B. Outlet boxes in smoke control walls (such as egress corridor walls) shall be offset at least 24” from each other where mounted on opposite side of the wall. If smoke control wall outlet boxes are not placed at least 24” apart, then the rear of the box shall be covered with a fire rated pad (such as “Metacaulk Box Guard”) which will expand and seal off the box in the event of a fire, or must be completely covered with a fire rated putty along the top, bottom, and sides of the box.

C. If new switches, receptacles, or similar devices are installed in existing outlet boxes, the following shall be provided:
1. Existing outlet boxes must be of sufficient size to accommodate new devices.
2. Existing outlet boxes must be of correct heights to conform with ADA and similar code heights. See subsequent information for correct mounting heights. Existing boxes that do not meet the new mounting height requirements shall not be reused for new devices or shall be moved to the new correct mounting heights.

3.9 INSTALLATION – RECESSED BOXES
A. Install so that device and/or coverplates shall be tight and plumb with wall finish.

B. Box supports are required of all interior switch and receptacle boxes unless excluded by the Engineer.

C. Install with device box supports equal to Caddy “H” series “Quick-mount” for interior use.

D. Boxes installed masonry walls may use the mortar fill or block sides to support the boxes provided the fill or sides are in close contact with the boxes and permanently prevent movement.

E. Ganging boxes:
1. Gang where possible.
2. Where interior multiple receptacle, switch, or communication outlets are indicated on the Drawings, boxes to be closely grouped, use Caddy “SGB” series of box brackets.

3. Do not widely space outlets indicated on the Drawings to be grouped.

F. Covers and rings:
   1. Cover with ½” raised galvanized device covers for exposed conduit work.
   2. Furnish with raised galvanized plaster rings for concealed conduit work.
   3. Provide single gang rings for single device mounts even if box is double gang.

3.10 INSTALLATION – CEILING BOXES

A. Install so that device and/or coverplates shall be tight and plumb with ceiling line or tight to exposed structural mounting.

B. Furnish with raised galvanized plaster rings for concealed box installation in plaster, wood, or gypboard ceilings.

C. Furnish 4” square or octagonal 4” nominal sized boxes for connecting to standard fixtures.

D. Structurally support boxes used for hanging lighting fixtures or other items in accordance with the Drawings and NEC Articles 410.

3.11 INSTALLATION – BOX MOUNTING HEIGHTS

A. Mounting heights of outlets: The height of each outlet shall be in accordance with the Specifications and as directed by Architect for special décor or other architectural features. Heights are given above finished floor to the center of the outlet box unless noted otherwise.

B. Standard Mounting Heights:
   1. Wall switches 48”
   2. Receptacles—General use 15”-18” (*1)
   3. Receptacles—Storage 24”
   4. Receptacles—Cabinet work Above splash
   5. Receptacles—Sinks Above lip of sink
   6. Desk Telephone/Data 15”-18” (*1)
   7. Disconnect Switches 48”-60”
   8. Receptacles in Service areas 24”

(*1) Locate outlet boxes as follows:
   a. Minimum height of receptacles and communication outlets is 15”. This minimum height is for the lowest operable part of the receptacle, and reflects the final height after all floor finishes (such as carpet) have been installed. For vertically mounted duplex wall outlets, this places the center of the box at no less than 16.5” AFF assuming vinyl tile (carpet or thicker floor covering will increase this height).
   b. Outlets in close proximity to each other shall be set at the same height to satisfy the most restrictive condition so as to avoid a staggered appearance.

3.13 CLEANING

C. Section 01 70 00 – Contract Closeout: Final cleaning.

D. Clean interior of boxes to remove dust, debris, and other material.

E. Clean exposed surfaces and restore finish.
SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Labels.
   3. Wire markers.
   5. Stencils.
   7. Lockout Devices.

B. Related Sections:
   1. Section 09 90 00 - Painting: Execution requirements for painting specified by this section.

1.2 SUBMITTALS

A. Section 01 30 00 - Submittals: Submittal procedures.

B. Product Data:
   1. Submit manufacturer’s catalog literature for each product required.
   2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

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

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Contract Closeout: Requirements for submittals.

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

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Material and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

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

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

1.5 ENVIRONMENTAL REQUIREMENTS

A. Section 01 50 00 – Construction Facilities and Temporary Controls: Environmental conditions affecting products on site.

B. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.
PART 2 PRODUCTS

2.1 NAMEPLATES
A. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
B. Letter Size:
   1. 5/16 inch high letters for identifying individual equipment and loads.
   2. 3/4 inch high letters for identifying grouped equipment and loads.
C. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS
A. Labels: Embossed adhesive tape, with 5/16 white letters on black background.

2.3 WIRE MARKERS
A. Description: Cloth tape, split sleeve, or tubing type wire markers.
B. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
   2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.

2.4 UNDERGROUND WARNING TAPE
A. Description: 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.1 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION
A. Install identifying devices after completion of painting.
   1. Lighting panelboards: Provide an engraved label indicating the panel name.
   2. Power and distribution panelboards: Provide an engraved label indicating the panel name. Provide engraved labels for each circuit breaker and switch position as well as main, spares and spaces. Typed directory cards are not acceptable.
B. Nameplate Installation:
   1. Install nameplate parallel to equipment lines.
   2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
   3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
   4. Secure nameplate to equipment front using rivets, or adhesive.
   5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
   6. Install nameplates for the following:
      a. Switchboards: Provide an engraved label indicating the switchboard name. Provide engraved labels for each circuit breaker as well as main, spares and spaces. Typed directory cards are not acceptable.
b. Power and distribution panelboards: Provide an engraved label indicating the panel name. Provide engraved labels for each circuit breaker and switch position as well as main, spares and spaces. Typed directory cards are not acceptable.

c. Panelboards.
d. Transformers.
e. Service Disconnects.
f. Starters and Disconnect Switches.

C. Panelboard Labels:
   1. Provide typed interior door index card identifying all circuits in lighting and appliance panelboards.

D. Label Installation:
   1. Install label parallel to equipment lines.

E. Underground Warning Tape Installation:
   1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION – 26 05 53
SECTION 26 05 90 - ELECTRICAL SYSTEMS TESTING

PART 1 GENERAL

1.1 SUMMARY
A. Provide all work required to test the electrical systems as required by these Specifications.

1.2 SCOPE OF WORK
A. The following systems will require written test reports submitted to the Owner and the Engineer or Architect:
   1. Fire alarm Systems (for publicly required documentation.)
   3. Grounding Test.
B. Test all wiring installed or connected by Division 26 for absence from damage, short circuits, accidental ground, and continuity. Report any instances of improper installation to the Engineer.
C. Test all remaining electrical equipment and systems. Perform equipment and system tests on site with equipment in installed position and as left for permanent use. The Contractor may keep his own knots as to the scope of items tested, date of tests, and a record of his findings provided they are complete, accurate, and reproducible.

1.3 SUBMITTALS
A. Where required, certify that test were performed, that systems tested performed successfully, and list conditions and names of persons present.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Provide all test equipment, temporary wiring, labor, etc., required to fully perform required or requested testing.
B. No additional compensation will be given to the Contractor for testing of electrical systems installed under this division of the specifications.

PART 3 – EXECUTION

3.1 REQUIRED TESTS
A. Conductor megger tests:
   1. After wires and cables are installed in conduits or raceways, but before being connected to devices and equipment, test the wiring systems for unintentional shorts, open circuits, or grounds by means of an approved type of portable “megger” tests.
   2. Do not subject ground fault circuit interrupter type breakers or receptacle to megger tests.
B. Electrical measurements:
   1. With the system energized, make line voltage and current measurements at all switchboards, panelboards, motors, HVAC equipment, and other electrically operated equipment under full load conditions.
2. Notify Engineer of all unusual readings or results, such as voltages above or below normal bands or operation or currents that exceed equipment or conductor ratings.

C. Equipment tests and adjustments:
   1. Test feeder circuits to ensure that panelboards and related equipment are connected to the proper feeder breakers or switches.
   2. Compare actual conductors installed with those required on the Drawings. Notify the Engineer of any deviation from the Drawings.
   3. Check all branch circuits to determine if wiring is connected to the proper circuit and identified correctly on the panelboard circuit label.
   4. Test all branch circuit receptacles for proper polarity and to make sure that they are correctly energized.
   5. Check dry-type transformer output voltages. Ensure that neutrals are properly grounded to the system ground. Adjust taps if necessary.
   6. Check lighting fixtures for proper lamping and full light output from all lamps.
   7. Set any circuit breakers with adjustable trip functions to the values selected by the Engineer or recommended by the manufacturer.
   8. Set ground fault protective device time and current trip levels as selected by the Engineer.
   9. Install thermal overload elements in all electro-mechanical starter, as determined from the manufacturer’s charts and actual motor running load amperage.
   10. Adjust any solid state overload relays in starters as determined from manufacture’s charts and actual motor running load amperage.
   11. Program, test and adjust fire alarm system components.
   12. Test other items of electrical equipment to insure that each and every one is properly connected and that voltage is properly applied to the device.
   13. Make and other special tests where specified under other Sections of Division 26.

D. Remove and replace any electrical wiring that is damaged by unintentional grounding or shorting, faulty connection, or during the testing process.

E. Special system testing:
   1. Fire alarm and other special systems shall be tested by the system installer or supplier.
   2. Refer to other Sections of the Specifications for performance requirements of these systems.
   3. Any portion of these systems that require programming, setting, initialization, identification, or related work shall be performed by the Contractor to place the system in complete, adjusted working order.

F. Submit three copies of all required written test, certified by the Contractor for approval. Test data shall include the name of the building, location, Architect and Engineer, Contractor’s name, equipment supplier, and other pertinent data required.

G. Provide any instruction to the Owner or Owner’s Representative regarding operation of equipment, systems, or features, and assist as required in informing and educating the Owner regarding the electrical equipment’s operating parameters.

H. Demonstrate the proper operation of all the electrical systems in the presence of the Architect, the Engineer, or the Architect’s designated representative. All systems shall perform to the Architect’s complete satisfaction.

END OF SECTION – 26 05 90
SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Occupancy sensors.

B. Related Sections:
   1. Section 26 05 53 - Electrical Identification: Product requirements for electrical identification items for placement by this section.
   2. Section 26 05 19 - Building Wire and Cable.
   3. Section 26 05 33 - Raceway and Boxes: Product requirements for raceway and boxes for placement by this section.
   4. Section 26 27 26 - Wiring Devices: Product requirements for wiring devices for placement by this section.
   5. Section 26 24 16 - Panelboards.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA FU 1 - Low Voltage Cartridge Fuses.
   3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   4. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.
   5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
   6. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
   7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Product Data: Submit manufacturer’s standard product data for each system component.
C. Manufacturer's Installation Instructions: Submit for each system component.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Contract Closeout: Requirements for submittals.
B. Project Record Documents: Record the following information:
   1. Actual locations of components and record circuiting and switching arrangements.
   2. Wiring diagrams reflecting field installed conditions with identified and numbered system components and devices.
C. Operation and Maintenance Data:
   1. Submit replacement parts numbers.
   2. Submit manufacturer’s published installation instructions and operating instructions.
   3. Recommended renewal parts list.
1.5 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Requirements for transporting, handling, storing, and protecting products.
B. Accept components on site in manufacturer’s packaging. Inspect for damage.
C. Protect components by storing in manufacturer’s containers indoor protected from weather.

1.7 WARRANTY
A. Furnish five year manufacturer warranty for components.

1.8 EXTRA MATERIALS
A. Furnish two of each occupancy sensor type.

PART 2 PRODUCTS
2.1 LIGHTING CONTROL SYSTEM
A. Manufacturers:
   1. Douglas.
   2. Hubbell.
   3. Substitutions: As approved by Engineer.
B. Product Description:
   1. Provide a complete low voltage lighting control system for the building as shown on the plans and specified herein. All components are to be supplied by the same manufacturer. The manufacturer shall be a supplier of this type of equipment for over 10 years. Part numbers used in these notes are for Hubbell Lighting Controls.

   2. Lighting Control Panels are to come factory pre-assembled and pre-programmed. Programming changes must be able to be accomplished on-site. The panel enclosure, interior and cover must be separable for ease of installation. Use Hubbell LX series panels.

   3. Relays mounted in the lighting control panels shall be full load relays suitable for all types of lamp loads up to 20 Amperes. Relays shall be mechanically latching and must have a physical ON/ OFF override built into the relay. Use Hubbell LXRL Relays.

   4. Programmable Relay Scanners shall be used to assign unique address to each relay. Each scanner input shall be capable of controlling any or all of the Scanner’s outputs. Overlapping groups of relays shall be possible. An optional ‘flick warn’ feature shall be available to flash the lights OFF five minutes prior to an upcoming OFF sweep. Pressing a local switch during this warning period shall exclude those lights from being turned OFF in the upcoming sweep. Subsequent sweeps shall be programmable to ensure these lights are not left ON all night.
5. The central astro-timeclock shall be capable of controlling all relays in the building. The timer shall have eight outputs to allow for eight completely independent zones of control. The Timer shall automatically account for daylight savings time as well as leap-year adjustments. The Timer shall be capable of providing unique scheduling for each day of the week and shall include up to 32 holiday schedules per year. Astronomic programming is available if require, as is photometric functions. To enable the photo functions, a LXPSPCO photo sensor head shall be connected to enable the photocell control of the 8 output channels.

6. Switches shall have integral LED’s that indicate both ON and OFF states (red=ON, green=OFF). The switch shall have a plastic cap to permit holding a paper identification label. Refer to the lighting plans for switch locations. Use Hubbell LXSW style switches.

2.2 OCCUPANCY SENSOR

A. Manufacturers:
   1. Watt Stopper.
   2. Novitas.
   3. Hubbell.

B. Product Description:
   1. General requirements:
      a. Technology:
         1) Utilize passive infrared technology for smaller offices, storage
            rooms, and similar areas.
         2) Utilize ultrasonic technology for restrooms and areas of
            significant occupant movements.
         3) Utilize combination passive infrared/ultrasonic technology for
            areas such as classrooms, workrooms, and other areas in which
            occupancy requires more sophisticated detection.
      b. Mount as follows:
         1) Wall mount in the same location as the standard room entrance
            lighting switch in smaller single occupancy rooms. To utilize
            wall mounted sensors, the room must meet the following criteria:
            a) Rectangular shaped of 200 sq. ft. or less.
            b) Normally used by single occupant.
            c) Unobstructed view of occupant from standard wall
               switch location.
            d) Do not use for irregularly shaped rooms, rooms with
               wall partitions that block sensor operation, longer
               hallways, or rooms larger than 200 sq. ft.
         2) Ceiling mount in all other occupancies.
      c. Sensor operation and requirements:
         1) Self contained, operated at line lighting voltage (120VAC or
            277VAC), for wall mounted locations as defined previously.
            Rating shall be 20A minimum for ballast loads and 16A
            minimum for incandescent loads.
         2) Sensor shall operate at 24VDC (approx. 14-30ma) for ceiling
            mount installations. Include power packs or similar devices to
            operate the actual lighting circuits controlled by the sensor.
3) LED in face of sensor that activates to indicate motion or presence of occupant.

4) Provide built-in:
   a) Automatic detection and energization (non-time-delay) upon sensing occupant.
   b) Field adjustable Off time delay.
   c) Field adjustable sensitivity.

2. Types of sensors:
   a. Wall mounted passive infrared or ultrasonic sensors:
      2) 180 degree motion sensing.
      3) Able to detect vertical and horizontal motion.
      4) Color of plate shall match color of standard wiring devices.
      5) Equal to Watt Stopper #WM series.
   b. Large area sensors:
      1) Dual technology passive infrared and ultrasonic, unless noted otherwise on the Drawings.
      2) Wide angle lens for office.
      3) Utilize long range narrow dispersion angle lens for detection of occupancy in longer hallways.
      4) Complete with any required adjustable mounting ceiling brackets.
      5) Equal to Watt Stopper DT-100 series.

3. Relays or “power packs” shall be used with low voltage sensors to control the lighting circuits as follows:
   a. Provide 24VDC unswitched power to operate sensors.
   b. Be controlled by 24VDC input from sensors.
   c. Include single normally open electro-mechanical or solid state output contact rated at 20A, 12VAC or 277VAC.
   d. Equal to the following Watt Stopper “power pack” components:
      1) A120-EP for 120V “master” applications.
      3) S-120/277/347-EP for “slave” applications where more than 1 lighting circuit is controlled by the sensor.

4. System control (low voltage) wiring:
   a. Low voltage multi-conductor cable between sensor and controls.
   b. Minimum #24AWG copper conductors.
   c. Conduit is required where wiring is installed in walls.
   d. Conduit is required where wiring is installed in ceiling spaces unless:
      1) Ceiling is not a return air plenum.
      2) Plenum rated cable is installed in return air plenum.

5. System performance requirements:
   a. Sensors and associated relays, if used, shall perform in a completely acceptable manner based upon the intended function of the space or room which they control.
   b. Anticipated use of a room is defined by the room title. Unusual or multiple use rooms shall have their operation defined by the Engineer.
   c. Siting of sensing devices is critical to proper operation and shall be confirmed with the Engineer prior to installation.
   d. Manufacturer’s standard sensor products are not necessarily substitutable on a one-for-one basis with those indicated or specified. Manufacturer
shall submit adequate number of sensors, devices, or additional equipment required to perform the intended functions.

PART 3 EXECUTION

3.1 INSTALLATION

A. General
1. Furnish and install all lighting controls complete as herein specified and as called for on the Drawings.
2. Clean all controls and leave free of any dirt, dust, grease, etc., at the completion of the job.

B. Coordination
1. The Contractor is responsible for verifying door schedules and room finishes to insure proper clearances from obstructions such as door openings.
2. Interferences:
   a. Carefully examine the complete areas as well as each individual room where controls are to be installed for interference with structure, wall finishes, bulletin boards, and similar items.
   b. Revise or relocate, after approval of the Engineer, items which conflict with structure, finishes, or equipment.
3. Thermostats:
   a. Coordinate with mechanical drawings to determine any conflicts with wall mounted thermostats adjacent to or above dimmer switches producing heat while in the dimmed mode.
   b. Relocate dimmer switches or coordinate with Division 15 to relocate wall thermostats to avoid false temperature sensing by thermostats.

C. Occupancy Sensors and Controls
1. Wall mount single small room self-contained occupancy sensors in same location as normal room light switch. Connect to line voltage lighting circuit.
2. Ceiling mount all occupancy sensors as follows:
   a. Locate office and classroom sensors in center of room or in corner of room as directed. Provide with proper lens to sense occupancy in either square or rectangular pattern as required by the area served.
3. Install relays or “power packs” in or adjacent to junction boxes to allow make-up of wiring. Mount relay junction boxes as follows:
   a. In accessible ceiling spaces, mount in ceiling space adjacent to sensor.
   b. In substantially inaccessible ceilings (such as gypboard, concealed spline, or similar types), mount as follows in the following order of priority:
      1) Adjacent to ceiling access door where door is provided.
      2) In wall switch box where On/Off wall switches are provided.
      3) In junction box located where normal wall switch would be located if wall switches are not provided.
      4) Alternate location as approved by Engineer.
4. Install and connect all power and control wiring.
5. Adjust sensor and controls as follows:
   a. Adjust sensitivity of each sensor.
   b. Adjust Off time delay of each sensor.
   c. Sensors may require additional adjustments after space or room occupancy and occupant behavior have been established.
6. Provide complete testing to insure sensor system is properly functioning. If equipment as installed fails to perform as required, Contractor shall relocate existing sensors or add additional sensor(s) to make the control system function properly with anticipated use of the space(s).

7. See Drawings to determine if standard wall switches shall be installed in any areas served by occupancy sensors. If so, connect wall switches ahead of the power to the relays or “power packs” and in series with the relay or “power pack” output relay to allow definite On/Off control to the sensor system.

3.2 ADJUSTING
A. Test each system component after installation to verify proper operation.
B. Confirm correct loads are recorded on directory card in each panel.

3.3 DEMONSTRATION:
1. Provide Owner training in the operation and capabilities of the entire system at the conclusion of the project.
2. Training shall be on the Owner’s premises at mutually agreed dates and times. Notify the Owner at least 5 working days prior to the demonstration.
3. Training shall be for a period of not less than 4 continuous hours on two different days, or additional time, not to exceed 4 additional hours, if so required by the Owner. Training shall be videotaped and a copy of the recorded training provided to the owner.
4. Inadequate or incomplete training shall be repeated at the Contractor’s expense.

END OF SECTION – 26 09 23
SECTION 26 21 00 - ELECTRICAL UTILITY SERVICES

PART 1 GENERAL

1.1 SUMMARY
A. Section includes arrangement with Utility Company for permanent electric service; payment of Utility Company charges for service; service provisions; and utility metering equipment.
B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Concrete pads.

1.2 SYSTEM DESCRIPTION
A. Utility Company: Xcel Energy
B. System Characteristics: 480Y/277 volts, three phase, four-wire, 60 Hertz.

1.3 SUBMITTALS
A. Section 01 30 00 - Submittals: Submittal procedures.
B. Submit Utility-Company-prepared drawings.

1.4 QUALITY ASSURANCE
A. Perform Work in accordance with Utility Company written requirements.

1.5 COORDINATION
A. Coordinate with utility company, relocation of overhead or underground lines interfering with construction. Where power lines are to be relocated, bill utility costs, directly to Owner.
B. Contact utility company regarding charges related to service installation. Include utility charges in this contract.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS
A. Where noted, the Contract Documents reflect the general locations and sizes of utilities known to exist and to which modifications and/or extensions are to be made.
B. It is the responsibility of the Contractor to field verify locations indicated and to coordinate with utility company personnel regarding establishment of service to the property.
C. Include with the bid all costs for utility work for which the utility requires reimbursement, unless noted specifically that the costs will be paid for by the Owner or other entity. Reimbursable costs may include, but are not limited to, the following items:
   1. Establishing services to the property of the voltage and type indicated on the Drawings.
   2. Providing underground service in lieu of overhead service.
   3. Removal of existing utility facilities at the site.
4. Installation and removal for temporary site utility service prior to establishment of permanent utility service.
5. Ditching or boring for utility lines.
6. Charges for reconnecting or removing and restoring services.
7. Overtime and/or additional materials required due to scheduling of shutdowns, voltage conversions, transformer replacement, or similar work after normal hours when made necessary due to the convenience of the Owner.
8. Other legitimate charges that require utility reimbursement.

D. The Owner is responsible for establishment of permanent utility service, down payment or deposits for such service, and similar matters.

E. If permanent services is established at the site prior to final occupancy by the Owner, coordinate with the Owner in having service transferred to the Owner’s account.

2.2 METER SOCKETS (METER CANS)

A. Instrument rated meter sockets (i.e., those that house instrument rated meters connected to current and/or voltage metering transformers) shall be furnished by the utility company.

2.3 PADMOUNTED METERING CUBICLE

A. Provide a padmounted metering cubicle (service connection cabinet), Contractor furnished, adjacent to the padmounted utility transformer.

B. Acceptable manufacturers:
   1. Erickson.
   3. Electrical Mechanical Industries (EMI).

C. Construction requirements:
   1. UL listed as a metering equipment enclosure.
   2. Padmounted painted steel or brushed aluminum housing of rigid construction.
   3. NEMA 3R enclosure rating.
   4. One hinged door for the utility side and one hinged door for the customer side. Door shall include latches that can be secured with utility type locks.
   5. Ground pad(s) for attachment of grounding conductors, bonded to the steel enclosure.
   6. Designed for bottom conductor entrance and exit.
   7. Bussing as follows:
      a. Copper only, with ampacity rating as noted on the Drawings.
      b. Include one bus bar for each phase conductor plus one for the neutral.
      c. Removable phase bus section to allow the installation of utility bus-bar type CTs.
      d. Include stand-off insulator supports for the bus.
      e. Rated for the service voltage.
      f. Rated for 2,000A maximum amperage.
      g. Include lug terminations for the incoming service lateral conductors from the padmounted transformer.
      h. Include lug terminations for the outgoing service entrance conductors to the building service entrance equipment.
   8. Internal vertical barrier between utility side and customer side with bushed upper opening for field connection of customer side service entrance cables.
2.4 CONCRETE PAD(S)

A. Provide the require reinforced concrete equipment pad for the padmounted utility transformer and padmounted metering cubicle.

B. Complete pad design and dimensions for the utility transformer shall be provided by the utility company. Pad for adjacent metering cubicle shall be of similar construction as the utility transformer. See Drawings for additional details.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 50 00 – Construction Facilities and Temporary Controls: Coordination and project conditions.

B. Verify service equipment is ready to be connected and energized.

3.2 INSTALLATION

A. General Installation

1. Contact utility company personnel and arrange for the installation of the electrical service. Notify the Engineer if the utility company does not agree to provide service as indicated on the Drawings.

2. Provide all Contractor work necessary to erect and supply the service entrance system and the utility metering.

B. Underground service provided by a padmounted transformer

1. Provide the transformer pad to utility company specifications.

   a. General pad construction requirements:

      1) Trowel finished structural grade pad.
      2) 3,000 psi compressive strength concrete mix.
      3) Max. 1/2" diameter gravel.
      4) Minimum of 6" thick.
      5) Dimensions shall be 7 ft. X 7 ft., or larger if so designated by the utility company.
      6) Footings:

         a) Minimum 6” wide footings on all sides.
         b) Footings shall reach at least 2” below the frost line, or be 24” deep, whichever is deeper.

      7) Install three #4 horizontally placed reinforcing roads centered in footing as follows:

         a) One rod 3” below top of pad
         b) One rod 3” above bottom footing.
         c) One rod in the center of the footing.

      8) General pad reinforcing steel:

         a) #4 reinforcing rods set horizontally in the vertical center of the pad and spaced a maximum of 12” on center each way.
         b) Reinforce edges of pad conduit opening w/ rods at each corner placed at 45 deg. To the opening (across corners). Do not place rods closer than 3” to any edge.
         c) Chamfer all edges.

   b. Pad ground grid:

      1) Provide at least two 5/8” X 8 ft. long copperweld ground rods.
      2) Provide a #1/0AWG bare copper ground tie between the rods.
3) Leave two #1/0AWG ground tails to connect to the transformer primary and secondary compartment ground pads.

2. Metering cubicle pad shall be similar in construction to the utility transformer pad except for:
   a. Locate pad so that clearance is at least 4 ft. from the door sides of the cubicle and at least 3 ft. from the non-door sides of the cubicle.
   b. Include a 3/4” X 10 ft. copperclad ground rod under the pad and connect to the cubicle ground pad with 1 #4/0 copper grounding conductor.

3. Locate metering equipment (CTs) inside a contractor provided exterior padmounted metering enclosure adjacent to the padmounted transformer.

4. Locate the instrument rated utility meter and meter socket on the side of the Contractor-furnished padmounted metering enclosure. Connect the metering equipment (CTs and PTs) to the meter socket with conduit, minimum 1-1/2”, or sized as required to house the utility meter wiring.

5. Service entrance connections:
   a. Stub up service entrance conductors in metering cubicle. Leave sufficient length for proper termination on transformer secondary spades.
   b. Mark conductors with colored tape to indicate which conductors are to be connected to which phase and neutral bushings.
   c. Provide assistance, if necessary, to utility company personnel in determining correct connections to transformers.
   d. Provide standard NEMA 2 hole compression connectors for connection of utility company service lateral conductors to padmounted transformer phase and neutral pads, unless lugs are provided by the utility company.
   e. Install and connect service entrance conductors between the metering cubicle and the building service entrance equipment.

6. Metering cubicle connections:
   a. Coordinate with the utility company regarding the utility-furnished service lateral conductors between the padmounted transformer and the metering cubicle.
   b. Install utility-furnished bus-bar CTs in the removal bus section on the utility side of the cubicle bus.
   c. Install utility-furnished instrument meter socket on the utility side of the cubicle. Provide bushed hole or nipple at meter socket connection for entrance of meter cable.
   d. Utility personnel will install metering wiring, meter, and make all connections to metering equipment.

END OF SECTION – 26 21 00
SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY
A. Section includes two-winding dry-type transformers.
B. Provide as shown on the Drawings and described in these Specifications.

1.2 REFERENCES
A. National Electrical Manufacturers Association:
   1. NEMA ST 20 - Dry Type Transformers for General Applications.
B. International Electrical Testing Association:

1.3 SUBMITTALS
A. Section 01 30 00 - Submittals: Submittal procedures.
B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, sound levels, and rated temperature rise.
C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

1.4 CLOSEOUT SUBMITTALS
A. Section 01 70 00 – Contract Closeout: Closeout procedures.
B. Project Record Documents: Record actual locations of transformers.

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

1.6 DELIVERY, STORAGE, AND HANDLING
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Product storage and handling requirements.
B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Transformers:
   2. GE Electrical.
   3. Siemens.
   4. Square D.
5. Substitutions: Not Permitted.
B. Vibration isolation: See section 26 05 00.

2.2 TWO-WINDING TRANSFORMERS
A. Primary Voltage: 480 volts, 3 phase.
B. Secondary Voltage: 208Y/120 volts, 3 phase.
C. Core construction:
   1. Construct of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses.
   2. Magnetic flux densities shall be well below the core steel saturation point.
   3. Clamp core laminations together with structural steel angles.
   4. Ground the core of the transformer to the enclosure by means of a flexible grounding conductor sized in accordance with NEMA, IEEE, and ANSI standards.
D. Coil construction:
   1. Two windings per phase.
   2. Continuous wound construction and impregnated with non-hygroscopic, thermosetting varnish.
   3. Winding BIL level shall meet or exceed minimum NEMA standards.
   4. Provide a minimum of four 2-1/2% full capacity primary taps per phase for transformers rated 15 KVA and above.
E. Winding temperature rise requirements:
   1. All insulating materials, regardless of specified temperature rise, must meet NEMA ST20 standards for a 220 deg. C UL component recognized insulation system.
   2. 115 deg. C rise transformers shall be capable of carrying a 15% continuous overload without exceeding a 150 deg. C rise in a 40 deg. C ambient.
   3. 150 deg. C rise transformers shall be capable of carrying their continuous rated load without exceeding a 150 deg. C rise in a 40 deg. C ambient.
F. Winding connections:
   1. Connect three phase transformers 480 VAC 3 wire delta primary and 208Y/120VAC 4 wire wye secondary.
   2. Primary winding taps:
      a. Provide a minimum of two 2-1/2% fully rated taps above rated voltage and a minimum of two 2-1/2% fully rated taps below rated voltage for all transformers rated 15KVA and greater.
      b. Where winding taps are provided, connect to the center (nominal primary voltage) tap unless directed otherwise.
G. Enclosures:
   1. Bolt the completed core and coil to the base of the enclosure via rubber vibration-absorbing mounts. No metal-to-metal contact between the core and coil and the enclosure is permitted.
   2. Enclosure types:
      a. Heavy gauge, sheet steel, ventilated NEMA 2 for 15 KVA and larger.
      b. Design ventilating openings to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code standards for ventilated enclosures.
   3. Floor mount for transformer weight exceeding 200 lbs.
   4. Degrease, clean, phosphatize, prime, and paint the entire enclosure with a grey, baked enamel.
5. The maximum temperature of the top of the enclosure shall not exceed 3 deg. C rise above a 40 deg. C ambient

H. Sound levels:
   1. For environments such as mechanical rooms, basement equipment rooms, and storage rooms not adjacent to occupied spaces shall guarantee that dry-type transformer(s) shall not exceed the following sound levels:
      a. 45dBA for transformers 15-50 KVA.
      b. 50dBA for transformers 51-150 KVA.
   2. For environments such as office areas, storage rooms adjacent to occupied spaces, schools, and similar locations, manufacturer shall guarantee that dry-type transformer(s) shall exceed the following sound levels:
      a. 42dBA for transformers 15-50 KVA.
      b. 47dBA for transformers 51-150 KVA.

I. Provide isolating type transformers with an aluminum electrostatic shield wound between the primary and secondary windings.

J. Non-linear load (K-factor) transformers:
   1. Provide where noted on the Drawings.
   2. Features:
      a. Rated 480-208Y/120V three phase, dry type, 60Hz fundamental.
      b. Conform to UL1561 for a “K” rating of 4 or greater.
      c. Supply rated 60 Hz current with a maximum of 150% nonlinear load when loaded to 100% of fundamental current.
      d. Neutral construction capable of carrying 200% of fundamental rated phase current.
      e. Electrostatic grounded aluminum shield between primary and secondary windings.
      f. Maximum hot spot temperature of 220 deg. C.
      g. Taps, terminations, and enclosure per standard construction.
      h. Maximum sound levels not to exceed 5 dBA above those of standard non K-factor transformers.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Assure NEC clearance on all sides for adequate ventilation.

B. Concrete housekeeping pads:
   1. Provide reinforced concrete housekeeping pad for transformers that are floor mounted.
   2. Pads may be omitted above grade level only by approval of the Engineer if floor loading is critical.
   3. Minimum pad height is 4”.
   4. Pin to the underlying floor slab.
   5. Internal reinforcing:
      a. Center horizontally in the pad.
      b. Reinforcing shall terminate no closer than 2” to the outside edge of the pad.
      c. Utilize minimum 3,000# concrete.
      d. Provide either #10/10 welded wire mesh or #3 steel reinforcing rods set 12” on center both ways.

C. Install vibration isolation.
D. Final conduit connections:
1. See Section 26 05 33 for additional details.
2. Conduits must enter sides or bottom of enclosure. Do not install conduit into top of transformer enclosure.
3. Use a minimum of 24” of liquid-tight flexible conduit for both primary and secondary side connections where conduits enter sides of transformer.
4. Conduits entering bottom of enclosure:
   a. Utilize only for floor mounted transformers.
   b. Stub above the floor or pad level and provided with an insulating bushing. Conduit stub-up shall be high enough off floor or pad to prevent direct exposure of conductors from front or side of enclosure.
   c. Provide a grounding bushing with grounding jumper from bushing to transformer case. Size jumper same as the enclosed feeder grounding conductor.

E. Remove or loosen (as required) internal shipping hold-down clamps or bolts to allow the transformer core and coil assembly to provide internal vibration and sound isolation from the transformer case.

F. Check that primary coil taps are correct. Measure output voltage under load and adjust if necessary.

3.2 TRANSFORMER GROUNDING

A. Transformer case ground:
1. Install ground lug or ground bar bonded to inside of transformer case for receiving all grounding and bonding conductors.
2. Bond case to structural steel or cold water line where available. If these grounding points are not available, utilize primary and secondary grounding conductors for the ground attachment. Ref. NEC Table 250-94 for sizing of grounding conductor related to secondary phase conductors, except that the maximum size required shall be #3/0AWG unless larger is indicated on the Drawings.
3. Provide driven ground rod if transformer is located outdoors.
4. Attach primary and secondary feeder grounding conductors to transformer case ground lug or ground bar.

B. Ground wye connected secondaries of dry type transformers with a properly sized bonding jumper as follows:
1. Install a bonding jumper in one of the following locations:
   a. Between the transformer secondary neutral bar or pad (usually designated as “XO”) and the case ground point in the transformer.
   b. Between the neutral bar or pad and the found bar in the first panel downstream of the transformer if the panel main circuit breaker or fusible switch serves as the transformer secondary disconnect.
   c. Between the neutral bar or neutral conductors and the ground bar in the secondary circuit breaker or fuse disconnect if no main downstream panelboard circuit breaker or fusible disconnect is installed.
2. Do not bond the transformer secondary neutral (grounded conductor) to the ground in more than one location.
3. Reference NEC Table 250-94 for sizing of jumper in relationship to secondary phase conductor size. Minimum size of bonding jumper is #8AWG.
4. Install the ground electrode conductor from the transformer to a structural steel member of the building, to a ground metal cold water pipe within 5 feet of the point of entrance of the cold water pipe into the building, or the other suitable...
electrodes as per NEC 250-30 if structural steel or local cold water piping is not available.

5. Where the dry type transformer is located adjacent to the service entrance point, a bond from the grounding connection at the transformer to the service entrance equipment building main grounding electrode conductor may be utilized without requiring a separate connection back to the grounding electrode(s) provided that the transformer grounding conductor is not larger than the service entrance grounding conductor.

6. Check building receptacle circuit voltage of neutral-to-ground to insure that neutral is properly bonded to ground.

C. Ground any electrostatic shield to the transformer ground point.

3.3 ADJUSTING

A. Section 26 05 90 – Electrical System Testing: Testing, adjusting, and balancing.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION – 26 22 00
PART 1 GENERAL

1.1 SUMMARY
A. Section includes main distribution switchboards.
B. Related Sections:
   1. Section 26 05 26 - Grounding and Bonding.
   2. Section 26 05 53 - Electrical Identification.

1.2 REFERENCES
A. American National Standards Institute:
   1. ANSI C12.1 - Code for Electricity Metering.
B. Institute of Electrical and Electronics Engineers:
   2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
C. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA FU 1 - Low Voltage Cartridge Fuses.
   3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   4. NEMA PB 2 - Deadfront Distribution Switchboards.
   5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
D. International Electrical Testing Association:

1.3 SUBMITTALS
A. Section 01 30 00 - Submittals: Submittal procedures.
B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, ground and switchboard instrument details.
C. Product Data:
   1. Clearly indicate the following:
      a. Voltage rating of the switchboard.
      b. Type of enclosure showing removable plates and conduit openings.
      c. Integrated equipment rating of switchboard.
      d. Ampacity, voltage rating, and maximum horsepower rating (if applicable) of each circuit breaker.
      e. Load served by each circuit breaker.
      f. Individual interrupting rating of each circuit breaker.
      g. Series interrupting rating, if required, for each circuit breaker and its downstream load.
      h. Type of trip unit, including adjustments, for all circuit breakers.
i. Load side lugs for all protective devices.

j. Size and type of fuses being furnished.

k. Ground fault protective devices or integral trip units, if provided.

l. Complete information on all through and section bus including ampacity rating and type of material.

m. Type of labels provided.

D. Test Reports: Indicate results of factory production and field tests.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Contract Closeout: Closeout procedures.

B. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

C. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Material and Equipment: Product storage and handling requirements.

B. Accept switchboards on site. Inspect for damage.

C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 50 00 – Construction Facilities and Temporary Controls.

B. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

A. Manufacturers:
   2. GE Electrical.
   3. Siemens.
   4. Square D.
   5. Substitutions: Not Permitted.

B. Voltage:
   1. Service voltage 480Y/277 3 phase 4 wire.

C. Product Description:
1. Furnish and install the switchboard as detailed and located on the Drawings.
2. Design, manufacture, and test the switchboard in accordance with applicable standards.
3. The switchboard shall consist of custom made free standing units that feature front accessible dead front construction equal to Square D Power-Style QED-2 multi-section type.
4. Service entrance main switchboard requirements:
   a. Bear a label stating “UL listed for use as service equipment” or similar statement indicating conformance to required standards. Include the manufacturer, place and date of manufacture, ampacity, voltage, and related information.
   b. Include barriers between the service connection and the rest of the switchboard per NEC Article 385-3.
   c. Rated ambient temperature for continuous equipment operation is 40 deg. C.
   d. Test and rate the switchboard as “Integrated Equipment.”

D. Construction Requirements:
1. Base made of structural steel members, bolted or welded to form a rigid frame.
2. Equipment Construction shall allow hoisting and lifting without special slings or straps.
3. Size so that the switchboard can be installed through a standard size doorway, or if equipment height or width precludes this type of installation, coordinate with Contractor regarding method and timing of installation.
4. Each switchboard section shall have the following features:
   a. An open bottom and individually removable top plate for installation and termination of conduit.
   b. Bottom conduit area clearly shown and dimensioned on the Shop Drawings.
   c. Vertical wireway front covers to permit access to the branch switch or circuit breaker load side terminals.
   d. All closure plates screw removable and small enough for easy handling by one man.
   e. Sections capable of being bolted together to form an electrically and mechanically continuous unit.
   f. Front and rear aligned sections.
   g. ANSI gray enamel paint finish over a rust-inhibiting phosphate primer.
   h. Front only accessibility requirements for depths up to 36” unless noted otherwise (side accessibility requirement is permissible where available for specific electrical room layout; refer to Drawings).
5. Bussing:
   a. Tin or silver plated copper for both through and section bus.
   b. Sufficient cross-sectional area to continuously conduct rated full load current with a maximum average temperature rise as determined by UL Standard 891.
   c. Rigidly braced bus bars that meet the integrated equipment rating of the switchboard.
   d. Main horizontal bus bars between sections:
      1) Locate to permit a maximum of available conduit area.
      2) Provisions for future additions including bus bars installed close to the end of the switchboard and prepunched to facilitate future bolted splice plates.
3) Bar supports, connections, and joints bolted with grade 5 carriage bolts and Belleville washers to minimize required periodic maintenance. Flat washers may be substituted for Belleville washers for copper bus construction only with the Engineer’s approval (note deviation from specification on any submittal documentation).

4) May be reduced in ampacity after the first section containing protective devices, but it shall not be reduced below 50% of the original ampacity.

5) Locate vertical section bussing immediately behind the protective devices in order to reduce the length of device stabs or connectors. Install section bus full height rated at a minimum of 80% of the total of all protective device ampacities including full load ampacity of all bussed space.

6) Provide a full length solid neutral of the same ampere capacity as the main horizontal bus unless noted differently on the Drawings.

7) Provide a full length non-tapered ground bar sized at a minimum of 25% of the main horizontal bus rating.

c. Integrated equipment rating:
   1) Single integrated equipment rating for each unit.
   2) Certify that all equipment is capable of withstanding the stresses of a fault equal to that of at least the overcurrent protective device contained therein.
   3) Establish the rating by actual manufacturer’s tests on equipment constructed similarly to the project switchboard.

2.2 CIRCUIT BREAKER PROTECTIVE DEVICES

A. Construction requirements for insulated case circuit breakers:

B. Main circuit breaker:
   1. Rated 480VAC or 600VAC with ampere trip and/or frame rating as indicated on the Drawings.
   2. 3 pole, insulated case type construction.
   3. Minimum of 100% rated individual fixed mounted. Do not group mount. Quick-make, quick-break, common trip, trip-free, and handle position trip indicating.
   4. A short circuit interrupting equal to or exceeding that indicated on the Drawings.
   5. Push-to-trip test button on face of breaker case.
   6. Trip unit constructed as follows:
      a. Solid state.
      b. Replaceable interchangeable continuous ampere rating plug available from 50% of frame rating to 100% of frame rating.
      c. True RMS sensing.
      d. Front accessible trip adjustments with adjustment screws or knobs located behind a sealable clear plastic cover. Provide adjustments as follows:
         1) Long time pickup of 0.5 to 1.0X rating plug adjustable in at least 7 increments.
         2) Long time delay adjustment (minimum of 3 bands).
         3) No instantaneous trip except for short circuit withstand override (type LS trip) for main circuit breaker.
         4) Short time pickup adjustment of at least 2.0 to 8.0X rating plug.
5) Short time delay adjustment (12t) with a minimum of 2 bands (“In” and “Out”).

e. An LCD window indicating instantaneous breaker current. Phase current monitored shall be selectable on the face of the breaker.

f. Trip indicators providing visible indication of whether the breaker tripped on overload, short circuit, or ground fault.

g. Provide integral adjustable ground fault protection. Ground fault protection shall have the following features:
   1) Include a separately mounted neutral current transformer used in conjunction with internal phase current transformers and wired to the breaker trip control.
   2) Adjustable ground fault pickup range of at least 0.2 to 1.0X rating plug with a maximum of 1,200A pickup. Provide a minimum of 5 adjustment setting points.
   3) Adjustable ground fault time delay with no more than 1.0 second delay for ground faults of 3,000A or more per NEC Article 230-95.

C. Feeder circuit breakers:
   1. Rated 480VAC.
   2. Ampere trip rating as indicated on the Drawings.
   3. 3 pole, molded or insulated case type construction as indicated on the drawings.
   5. A minimum of 80% rated.
   6. Quick-make, quick-break, common trip, trip free, and handle position trip indicating.
   7. A short circuit interrupting equal to or exceeding that indicated on the Drawings.
   8. Thermal magnetic or solid state trip unit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 50 00 – Construction Facilities and Temporary Controls: Coordination and project conditions.

B. Verify surface is suitable for switchboard installation.

3.2 INSTALLATION

A. Provide all work as necessary to erect and supply the switchboards.

B. Interior concrete pads:
   1. Provide concrete pad for all interior floor mounted switchboards.
   2. Pad shall be a minimum of 4” thick or higher if so noted on the Drawings, tool finished.
   3. Reinforce pad with #10 10X10 welded wire mesh or with #4 reinforcing rods set 12” on center both ways in the center of the pad.
   4. Pin pads to concrete floor with short lengths of #4 re-bar.

C. Install in accordance with NEMA PB 2.1.

D. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

E. Install engraved plastic nameplates in accordance with Section 26 05 53.

F. Install breaker circuit directory.
G. Ground and bond switchboards in accordance with Section 26 05 26.

3.3 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 7.1.

3.4 ADJUSTING
A. Section 26 05 90 – Electrical System Testing: Requirements for starting and adjusting.
B. Adjust electronic trip of magnetic trip circuit breakers as directed.
C. Notify Engineer of the completion of the trip setting with “as-left” settings recorded.

3.5 CLEANING
A. Section 01 70 00 – Contract Closeout: Final cleaning.
B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION – 26 24 13
SECTIONS 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY
A. Section includes branch circuit panelboards.
B. Related Sections:
   1. Section 26 05 53 - Electrical Identification

1.2 REFERENCES
A. Institute of Electrical and Electronics Engineers:
   1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
B. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA PB 1 - Panelboards.
   3. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
C. International Electrical Testing Association:
D. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
E. Underwriters Laboratories Inc.:
   1. UL 67 - Safety for Panelboards.
   2. UL 1283 - Electromagnetic Interference Filters.
   3. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS
A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
C. Product Data:
   1. Submit manufacturer’s data demonstrating compliance with this Specification and the Drawings in accordance with Section 26 05 00. Information on each panel shall include but not be limited to the following:
      a. Voltage, phase, and number of wires.
      b. Schedule or description of each panel indicating number, trip (or size), number of poles, and type of circuit protective devices.
      c. Integrated interrupting capacity of the panel.
      d. Bus material and bus bar or main lug ampacity.
      e. Ground bars and isolated ground bars.
      f. RMS symmetrical ampere interrupting rating.
      g. Enclosure mounting and details of construction.
      h. Identification plates if supplied by manufacturer.
      i. All dimensions.
1.4 CLOSEOUT SUBMITTALS
   A. Section 01 789 - Closeout Submittals: Requirements for submittals.
   B. Project Record Documents: Record actual locations of panelboards and record actual
circuiting arrangements.
   C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of
replacement parts and supplies; and recommended maintenance procedures and intervals.

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

PART 2 PRODUCTS
2.1 BRANCH CIRCUIT PANELBOARDS
   A. Manufacturers:
      2. GE Electrical.
      3. Siemens.
      4. Square D.
      5. Substitutions: Not Permitted.
   B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch
circuit panelboard.
   C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings.
Furnish copper ground bus in each panelboard; furnish insulated ground bus as indicated
on Drawings.
   D. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 240 volt
panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated
on Drawings.
   E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit
breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits,
Type HACR for air conditioning equipment circuits, Class A ground fault interrupter
circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.
   F. Enclosure: NEMA PB 1, Type 1.
   G. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20
inches wide for 480 volt panelboards.
   H. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed
hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's
standard gray enamel. Door-in-door construction.

PART 3 EXECUTION
3.1 INSTALLATION
   A. Provide all work as necessary to erect and supply the panelboards.
B. Install panelboards in accordance with NEMA PB 1.1.
C. Install panelboards plumb.
D. Install recessed panelboards flush with wall finishes.
E. Install filler plates for unused spaces in panelboards.
F. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.
G. Install engraved plastic nameplates in accordance with Section 26 05 53.
H. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL
A. Inspect and test in accordance with NETA ATS, except Section 4.
B. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

3.3 ADJUSTING
A. Section 26 05 90 – Electrical System Testing: Requirements for starting and adjusting.
B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION – 26 24 16
PART 1 GENERAL

1.1 SUMMARY

A. Section includes wall switches; receptacles; multioutlet assembly; and device plates and decorative box covers.

B. Related Sections:
   1. Section 26 05 33 - Raceway and Boxes: Outlet boxes for wiring devices.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA WD 1 - General Requirements for Wiring Devices.
   2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Section 01 30 00 - Submittals: Submittal procedures.

B. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

1.4 QUALIFICATIONS

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

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
   1. Hubbell.
   2. Leviton.
   5. Substitutions: Not permitted.

B. Product Description: NEMA WD 1, General-Duty, AC only general-use snap switch.
   1. General requirements:
      a. Quite type.
      b. Rated for use at 120-277VAC.
      c. Rated for 20A unless noted otherwise on the Drawings.
      d. Silver alloy contacts.
      e. Plated (not galvanized) mounting strip with self-grounding clip mounted at screw end of strap.
      f. Permanently lubricated spring and pivot points.

2.2 RECEPTACLES

A. Manufacturers:
   1. Hubbell.
   2. Leviton.
   5. Substitutions: Not permitted.
B. Product Description:
1. General requirements:
   a. Grounding type.
   b. Double-wipe or triple-wipe plug attachment contacts.
2. General convenience receptacles (20A or less):
   a. Duplex type.
   b. Provide with self-grounding clip on mounting strap.
   c. Flat face flush with plate.
   d. Nylon face.
3. Ground fault circuit interrupter (GFI or GFCI) receptacles:
   a. UL listed as a Class A ground fault protective device that trips at a ground fault current level of 6 milliamps or more.
   b. Have “test” and “reset” pushbuttons on the face of the receptacle.
   c. Rectangular face.
   d. Meet the requirements of UL 943, effective 1/1/2003, including:
      1) Prevent functioning if miswired (reversed line/load).
      2) Increased corrosion and moisture resistance.
      3) Overvoltage and surge test.
      4) Improved radio frequency immunity.
4. Devices greater than 20A:
   a. Simplex type.
   b. Grounding type unless noted otherwise on the Drawings.

2.3 WALL PLATES
A. Manufacturers:
   1. Hubbell.
   2. Leviton.
   5. Substitutions: Not permitted.
B. Product Description:
   1. Provide all device plates standard size. Large sizes may be provided to conceal installation irregularities only where specifically approved by the A/E.
   2. Wet or damp location installations shall conform to NEC Article 410-57 with the following provisions:
      a. Damp locations:
         1) Double “flap” covers (one flap per receptacle plug-in position) that are weatherproof in the closed or sealed position for non-GFCI receptacles.
         2) Single “flap” covers that are weatherproof in the closed or sealed position for GFCI receptacles.
      b. Exterior and all interior wet locations:
         1) Provide GFCI receptacles in these locations.
         2) Single covers that are weatherproof when cord plugs are installed in the receptacle.
         3) Provide covers with gaskets or grooves that prevent the entry of moisture between the cover and the device.
         4) Covers shall be manufactured by Leviton, Taymac, or approved equal.
   3. Interior locations:
a. #302/304 alloy 0.032” minimum thickness non-magnetic smooth or brushed stainless steel plates for heavy duty use in mechanical rooms, machine rooms, storage areas, and similar locations.

b. #430 alloy 0.030” minimum thickness smooth or brushed stainless steel plates for use in standard mechanical rooms, machine rooms, storage areas, and similar locations.

c. Nylon or high impact hospital grade plastic plates (standard plastic or phenolic plates are not acceptable) for other areas.

4. Coverplates in special areas will require being coordinated as to color of exposed parts and coverplates. Coordinate with the Architect prior to installation of these types of plates.

2.4 DEVICE COLORS
A. White finish is the standard color for all switches and receptacles unless noted.
B. Install brown or black finish devices on dark colored surfaces or where receptacles are of higher amperage rating than 20A.
C. Coordinate with the Architect where special surfaces are encountered.
D. Special receptacle colors:
   1. Orange finish or orange indications when of the isolated ground type.

2.5 SCHEDULE OF DEVICES
A. Schedule of Standard Devices includes device numbers for Hubbell for the purpose of setting a quality standard.
B. Cross-reference: Hubbell 5352 series of receptacles are considered equivalent to other manufacturer’s 5362 series. Hubbell 1200 series of switches are considered equivalent to other manufacturer’s 1200 series.
C. Schedule of Standard Devices
   SPST Wall Switch, 20A: #HBL1221
   3-Way Wall Switch, 20A: #HBL1223
   4-Way Wall Switch, 20A: #HBL1224
   Simplex Receptacle: Type as noted
   Duplex Receptacle, 20A: #5352
   Duplex Receptacle, EWC, 20A: #5352
   Duplex Receptacle, GFI, 20A: #GF5352A
   Duplex Receptacle, 15A, IG & Hospital Grade: #IG8200
   Duplex Receptacle, 20A, safety type: #HBLSG63H

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify outlet boxes are installed at proper height.
B. Verify wall openings are neatly cut and completely covered by wall plates.
C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION
A. Clean debris from outlet boxes.
3.3 INSTALLATION

A. General device installation requirements:
   1. All devices and plates plumb and parallel to adjacent surfaces or trim.
   2. Mount switches with the long dimension of the device vertical.
   3. Mount general convenience receptacles with the long dimension vertical with the ground pin on the bottom.
   4. Where receptacles are installed over counter splashes or in exterior locations, install horizontally.
   5. Device face must be flush with the finished trim coverplates and plates must be tight to surfaces over which they are installed.

B. Coordination
   1. The Contractor is responsible for verifying door schedules and room finishes to insure proper clearances from obstructions such as door openings.
   2. Interferences:
      a. Carefully examine the complete areas as well as each individual room where controls are to be installed for interference with structure, wall finishes, bulletin boards, and similar items.
      b. Revise or relocate, after approval of the Engineer, items which conflict with structure, finishes, or equipment.

C. Receptacles:
   1. Generally install by a pigtail connection to the branch circuit, where the branch circuit is fed-through the outlet box.
   2. Where the receptacle is the last outlet on the branch circuit, connect the branch circuit conductors directly to the last receptacle.
   3. Unless the branch circuit is protected by GFCI circuit breaker in the panelboard feeding the branch circuit, provide GFCI receptacles, whether specifically indicated on the Drawings or not.
      a. Install where noted on the Drawings or where required by Code, all exterior locations, including wall and roof receptacles, within 6 feet of sinks, in elevator pits and elevator machine rooms.
      b. GFCI receptacles are to be pigtailed to branch circuit conductors and shall not be installed in “feed-through” applications unless specifically noted otherwise.
   4. Safety receptacles:
      a. Install where noted on the Drawings.
      b. Install in rooms or areas accessible to and normally occupied by children under the age of 12.

D. Switches:
   1. Connect switches to the proper circuits and lighting fixtures as indicated on the Drawings. Consult the Engineer for interpretations of fixture switching if required.
   2. Where more than one switch occurs in one outlet box and causes 300V or more to exist between devices (typical for two or more snap switches on separate branch circuits in a 480Y/277V system), a barrier must be provided for isolation to meet NEC 404.8(B) requirements.
   3. Snap (toggle) switches may be used for disconnect of smaller single phase motor and equipment loads rated 277V and below where switches are rated for motor use.

E. Plates:
   1. Use single piece plates for all ganged device locations.
2. Where coverplates do not completely conceal the rough openings for the devices, it is the responsibility of the Contractor to patch, paint, etc., around the opening to the satisfaction of the A/E.

3. Refer to Section 26 05 53 for labeling.

3.4 ADJUSTING
A. Section 26 05 90 – Electrical System Testing: Testing, adjusting, and balancing.
B. Adjust devices and wall plates to be flush and level.

3.5 CLEANING
A. Section 01 70 00 – Contract Closeout: Final cleaning.
B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION – 26 27 26
SECTION 26 28 13 - FUSES

PART 1 GENERAL

1.1 SUMMARY
   A. Section includes fuses and spare fuse cabinet.

1.2 REFERENCES
   A. National Electrical Manufacturers Association:
      1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 DESIGN REQUIREMENTS
   A. The contractor shall be responsible for coordination with other trades and equipment suppliers to verify exact load and connection requirements.
   B. Reasonable modifications shall be made without cost to the Owner to the specified fuse sizes if dictated by the exact equipment selected.
   C. See Part 3- Execution for possible changes required by modifications to specified HVAC or motor operated equipment.
   D. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment.
   E. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays.

1.4 SUBMITTALS
   A. Section 01 30 00 - Submittals: Submittal procedures.
   B. Submit manufacturer’s data demonstrating compliance with this Specification. Include the following data:
      1. Device’s catalogue data.
      2. Ampere rating.
      3. Voltage rating.
      4. UL Class.
      5. Physical fuse construction.
      7. Interrupting rating.

1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 – Contract Closeout: Closeout procedures.
   B. Project Record Documents: Record actual sizes, ratings, and locations of fuses.
1.6 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 MAINTENANCE MATERIALS
   A. Furnish two fuse pullers.

1.8 EXTRA MATERIALS
   A. Furnish three spare fuses of each Class, size, and rating installed.

PART 2 PRODUCTS

2.1 FUSES
   A. Manufacturers:
      1. Bussmann.
      2. Littelfuse.
      3. Shawmut.
      4. Cefco.
      5. Substitutions: Not Permitted.
   B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.
   C. Voltage: Rating suitable for circuit phase-to-phase voltage.
   D. UL listed for 250VAC, 300VAC, or 600VAC as required by the voltage of the system on which the fuse is installed.
   E. Fuses rated 600a and below:
      1. UL Class RK5:
         a. Rejection feature.
         b. Dual element time delay with copper link short circuit sections.
         c. Current limiting.
         d. Capable of interrupting a 200,000A RMS symmetrical short circuit when applied at the rated fuse voltage.
         e. Equal to Buss FRN-R or FRS-R).
         f. Used for protection of:
            1) HVAC equipment and motors.
            2) Transformers.
            3) Feeder circuits.
            4) Main service entrance switch.
      2. UL Class CC:
         a. Rejection feature may be provided, but is not required.
         b. Time delay (not fast-acting)
         c. Capable of interrupting at least 10,000A RMS symmetrical short circuit when applied at the rated fuse voltage.
         d. Miniature 13/32” X 1-1/2” cartridge size.
         e. Equal to Buss FNQ, Littlefuse FLQ, Shawmut ATQ, or Cefco CNQ.
         f. Used for protection of:
1) Control circuits.
2) Control transformers.
3) Exterior lighting fixtures. Refer to Section 26 50 00 for details on fuse sizing and installation details.

2.2 SPARE FUSE CABINET

A. Product Description: Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified.

B. Doors: Hinged, with hasp for Owner's padlock.

C. Finish: Gray enamel.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Remove fuses from abandoned circuits.

B. Maintain access to existing fuses and other installations remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

A. Install fuse with label oriented so manufacturer, type, and size are easily read.

B. Install spare fuse cabinet as indicated on Drawings.

C. Fuse sizes for HVAC and motor operated equipment:
   1. Approximate fuse sizes are indicated on the Drawings and are based on estimated equipment characteristics of the specified mechanical equipment.
   2. Field determine exact HVAC equipment provided and size fuses for equipment that is actually installed, paying close attention to the equipment label.
   3. Provide increased fuse or disconnect sizes if required to accommodate larger equipment than that originally specified.
   4. Costs for increasing disconnect ampacity, fuse cartridge size, or other similar changes shall be compensated by Division 25 where selection, purchase, and installation of electrically larger or more demanding equipment is made at the discretion of Division 25.
   5. Equipment data shall be interpreted by the Engineer as necessary where recommended fuse size deviates from the estimated sizes shown on the Drawings.

END OF SECTION – 26 28 13
SECTION 26 28 19 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY
A. Section includes fusible and nonfusible switches.
B. Related Sections:
   1. Section 26 28 13 - Fuses.

1.2 REFERENCES
A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
B. International Electrical Testing Association:

1.3 SUBMITTALS
A. Section 01 30 00 - Submittals: Submittal procedures.
B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS
A. Section 01 70 00 – Contract Closeout: Closeout procedures.
B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

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

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES
A. Manufacturers:
   1. Square D.
   2. General Electric.
   3. Cutler Hammer.
   4. Siemens.
   5. Substitutions: Not Permitted.

B. Product Description:
   1. Safety switch requirements:
      a. Horsepower rated for use as a motor disconnect.
      b. Capable of interrupting the locked rotor current of the load served.
      c. Dead-front construction.
      d. Steel exterior disconnect handles that are not a part of the cover. Curved wire or rod type handles are not acceptable.
      e. Quick-make, quick-break over-center toggle action to preclude contact teasing.
f. Individual open switch blades which are fully visible in the OFF position when the door is open.
g. All current carrying parts plated by electrolytic process.
h. General duty where:
   1) Rated for a nominal voltage of 240VAC or less.
   2) Rated 400A or less.
i. Heavy duty with blade arc suppressor where:
   1) Rated for a nominal voltage above 240VAC.
   2) Rated above 400A.
   3) Required to be furnished to accommodate Class R fuse rejection clips (see below).
   4) Noted on the Drawings.
j. Provide Class R fuse rejection clips if the switch is designated as fusible type and is rated 600A and below.

C. Fuse clips: Designed to accommodate NEMA FU 1, fuses.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
   1. Square D.
   2. General Electric.
   3. Cutler Hammer.
   4. Siemens.
   5. Substitutions: Not Permitted.

B. Product Description:
   1. Safety switch requirements:
      a. Horsepower rated for use as a motor disconnect.
      b. Capable of interrupting the locked rotor current of the load served.
      c. Dead-front construction.
      d. Steel exterior disconnect handles that are not a part of the cover. Curved wire or rod type handles are not acceptable.
      e. Quick-make, quick-break over-center toggle action to preclude contact teasing.
      f. Individual open switch blades which are fully visible in the OFF position when the door is open.
      g. All current carrying parts plated by electrolytic process.
      h. General duty where:
         1) Rated for a nominal voltage of 240VAC or less.
         2) Rated 400A or less.
      i. Heavy duty with blade arc suppressor where:
         1) Rated for a nominal voltage above 240VAC.
         2) Rated above 400A.
         3) Required to be furnished to accommodate Class R fuse rejection clips (see below).
         4) Noted on the Drawings.
j. Provide Class R fuse rejection clips if the switch is designated as fusible type and is rated 600A and below.

C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

E. Furnish switches with entirely copper current carrying parts.

2.3 SNAP TOGGLE SWITCH ASSEMBLIES.

A. Snap (toggle) switch requirements:
   1. Single Phase 115V or 277V fractional horsepower motors, variable air volume boxes, electric duct heaters, and related items that do not require an external (Contractor furnished) starter may use a general use 120-277V rated snap switch or manual motor starter (as indicated) for the disconnect means where local code allows and the Drawings specifically indicate.
   2. Minimum snap switch ampacity as follows:
      a. Rated for motor use.
      b. Rated minimum of 15A.
      c. Rated minimum of 20A for full load currents of 10A to 15A.
      d. Provide enclosed safety switch or MCS for loads greater than 15A.
   3. Refer to Section 26 27 26 for snap switch specifications.

2.4 CORD AND PLUG ASSEMBLIES

A. Cord and plug connected devices and equipment:
   1. Provide a cord with a plug to attach the fixed electrical system to appliances, motors less than 1/8HP, control panels, and similar installations served at 120V (nominal) and above, unless the device includes an integral disconnect switch.
   2. Cords shall be minimum #14AWG and include a grounding conductor. Voltage rating shall meet or exceed the branch circuit operating voltage. See Section 26 05 19 for additional requirements for cords.
   3. Provide a matching plug, NEMA style, for each plug. Plugs shall be grounded unless specifically approved otherwise.

2.5 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
B. Short Circuit Current Rating: UL listed for 10,000A RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere).

PART 3 EXECUTION

3.1 INSTALLATION

A. Furnish and install motor, circuit, and equipment disconnects required for all electrically operated equipment unless said disconnects are furnished under another Division of the Specifications or are furnished as an integral part of the equipment.
B. Mount disconnect switches, circuit breakers, molded case switches, and related items adjacent to the equipment controlled unless indicated otherwise on the Drawings.
C. Properly proper structural support for the disconnecting equipment. Support may include Unistrut type channels, brackets steel angles, factory-made support shelves, proper anchoring to concrete, steel, or masonry walls, or other support suitable to the Architect and Engineer.

D. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.

E. Height: 5 feet to operating handle.

F. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.

G. Install engraved plastic nameplates in accordance with Section 26 05 53.

H. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

END OF SECTION – 26 28 19
SECTION 26 51 00 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK
A. Extent of Work as shown on the Drawings and described in these Specifications.
B. Prior to submittal, examine Architect's reflected ceiling plan in detail and insure that every fixture submitted has proper mounting accessories for ceiling and layout indicated.

1.2 STANDARDS
A. ANSI Standards:
   1. LE 4  Recessed luminaires.
B. IES Standards:
   2. LM-80 Measuring Lumen Maintenance of LED Light Sources.
C. CBM standards.

1.3 SUBMITTALS
A. Submit manufacturer's data demonstrating compliance with these Specifications and the schedule on the Drawings in accordance with Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Fixtures:
   1. As scheduled on the Drawings.
   2. Substitutions according to Section 26 05 00. Prior approval is required for substitutions.

2.2 GENERAL FIXTURE REQUIREMENTS
A. Provide hangers, hardware, supports, grid attachment clips, canopy extensions, and related items as required by applicable codes and standards.
B. Provide factory or field assembled frames for recessed gypboard or plaster mounted fixtures.
C. Furnish fixtures with specified or scheduled finishes.
D. Diffusers shall be of the thickness as specified in the Fixture Schedule on the Drawings. If no thickness is specified, the minimum diffuser thickness is 0.125" (0.140" nominal thickness).
E. All painted fixtures shall be painted after fabrication.

2.3 LIGHT EMITTING DIODE (LED) LIGHTING FIXTURES
A. Refer to the Lighting Fixture Schedule on the Drawings for specific details.
B. General requirements:
   1. Fixtures shall comply with the following UL standards, where applicable:
      a. UL 8750 (new fixtures).
2. Testing under IES shall be for a minimum of 6,000 hours, with lifetimes projected from this information.
3. Testing results for individual fixture types shall be submitted to the Engineer when requested.

C. LED fixtures shall be warranted by the manufacturer for a minimum of five years.

D. Heat dissipation from all LED fixtures, modules or drivers shall be controlled via passive convection methods. No fans shall be required for proper operation.

2.4 LIGHTING FIXTURE FUSES AND FUSEHOLDERS

A. Fuse requirements: See Section 26 28 13.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish and install all fixtures complete as herein specified and as called for in the Fixture Schedule on the Drawings.

B. Interferences: Carefully examine the complete areas as well as each individual room where fixtures are to be installed for interference with piping, beams, ducts, etc. Where any such interferences occur, provide fixtures with proper type suspension to overcome such interferences.

C. The fixtures in each room or area must all be hung the same distance above the floor except where noted.

D. Unless otherwise directed, must not be hidden or obstructed, wholly, or in part, by any piping, ducts, etc., running directly under the fixtures.

E. Where the bodies of fluorescent fixtures are used as raceways for branch circuit wiring, use wiring with an insulation rating of at least 90 deg. C. Carefully and securely clamp wiring within the fixture body to positively prevent contact of the wires with the ballast.

F. Clean all fixtures and leave free of any dirt, dust, grease, etc., at the completion of the job.

3.2 INTERIOR FIXTURE SUPPORT AND WIRING

A. Provide fixtures with any mounting accessories or supports required. Items required for support may include structural supports, mounting bolts, beam clamps, suspension items, or similar materials required to suspend and/or support the fixtures.

B. Recessed mounted fixtures installed in lay-in ceilings:
   1. Attach to lay-in grid with clips as required by NEC 410-16(C).
   2. Connect the fixtures to the branch circuit wiring system by short lengths of flexible metal conduit ("whips") to allow easy removal and servicing of the fixtures.
   3. No more than one fixture may be served by a single flexible whip. Do not "daisy chain" between fixtures with flexible conduit.
4. Do not connect the lighting fixture to the branch circuit wiring system with EMT or other rigid conduit means.

5. Feed whips from permanently mounted junction boxes above the ceiling lines. An individual junction box shall serve no more than four recessed fixtures.

6. Support surface and recessed linear fluorescent fixtures by means other than the ceiling grid where the fixtures are of a weight greater than the grid can support. In these cases, provide at least two independent support wires connected to diagonal corners of the fixtures, and run directly from the corner connection to the permanent structure.

7. Provide downlight fixture suspension bars equal to Caddy “517” series.

C. Recessed mounted fixtures installed in gypboard or plaster ceilings:
   1. Junction boxes feeding lighting fixtures shall not be installed above inaccessible ceilings.
   2. Connect fixtures to the branch circuit wiring system in one of the following methods:
      a. If fixtures can be completely serviced from below, including ballast replacement, or if there is not equipment above the ceiling line that would require removal of the fixture for servicing of equipment, EMT or similar rigid steel conduit or tubing may be used to connect between fixtures.
      b. If fixtures require removal for servicing, or if other equipment located above the ceiling line requires removal of the fixture for servicing of equipment, flexible metal conduit shall be used to interconnect the fixtures.

3. Troffers:
   a. Include a support frame on all four sides of the fixture. Frame may be field fabricated or supplied by the lighting fixture manufacturer.
   b. Field fabricated support frames may include metal wall studs or ceiling splines turned edge-wise and screwed or bolted to the ceiling, or other suitable methods approved by the A/E.

4. Downlights:
   a. Include flat mounting pan with fixture components.
   b. Attach to ceiling structure with slips, bolts, anchors, or extendable bars. Do not lay on top of ceiling surface without attaching to permanent structure or ceiling suspension members.
   c. Provide any required trim extension for recessed downlights reflector cones in needed due to thick ceiling surfaces.

D. Surface mounted fixtures:
   1. On grid ceilings attach to the ceiling with grid clips (Caddy “4G” series or equal) or other adequate support mechanism. Support fixtures that exceed the weight capabilities of the grid by directly anchoring the fixture to the structure in at least two locations on diagonal ends of the fixture.
   2. On non-accessible ceilings (such as gypboard) support by means of sheet metal brackets, steel channel or angles, or similar means installed above the permanent ceiling line and bolted through the ceiling material to the fixture housing. Do not attach surface mounted fixtures on gypboard with only toggle bolts or screw anchors unless specifically so approved by the Engineer.
3. On masonry walls support independently of the back box or junction box with masonry anchors unless the box has been specifically listed for such application. Support fixtures longer than two feet by masonry anchors at each end of the fixture in addition to any intermediate support required.

4. Under counter or under cabinet task lighting fixtures:
   a. Mount fixtures so that the top of the fixture is securely attached to the bottom of the upper cabinet or counter top.
   b. Do not mount with back of fixture against back wall.
   c. Back of fixture is defined as the side if the fixture opposite the lensed side.

E. Suspended fixtures:
   1. Cable suspension:
      a. Concrete structure:
         1) Install inserts into the bottom of structural concrete beams, braces, tee legs, tee flanges, box or carton formed floors, or poured concretes floors shall be epoxy-filled type equal to Hilti. Do not provide standard expansion inserts.
         2) Inserts installed into the sides of poured concrete walls may be either standard expansion type or epoxy-filled inserts.
      b. Metal structure:
         1) Coordinate with the Architect to determine load bearing capacity of corrugated metal decks or similar materials.
         2) Provide rigid attachment to the metal deck materials.
         3) If deck materials are not capable of adequate support of the fixtures, install additional steel channels, angles, beams, or similar structural reinforcing materials to support the fixtures and their hanging mechanism.
      c. Concrete block walls:
         1) Inserts installed in the sides of block walls may be standard expansion type unless block wall cells are unfilled.
         2) Unfilled blocks may require additional reinforcement of anchors to properly support the cable attachment and avoid breaking the block wall. Consult the Engineer for resolution.

   2. Stem and rod suspension:
      a. Stem requirements:
         1) Hollow to allow the passage of branch circuit conductors down to the fixture.
         2) Furnished by the fixture manufacturer.
         3) Of sufficient length, including any adjustments necessary for varying structure height above grade to provide uniform suspension height above finish floor lines.
         4) Include canopies for attachment to junction or outlet boxes.
      b. Rod requirements:
         1) Suspend fixture with all-thread type rod from the structure where required or noted.
         2) Rod shall attach to a suitably supported junction box.
3) Suspension may require the installation of uni-strut type bracing or additional support plates on the back of the fixture(s) to avoid pull-out of the fixture housing from the rod attachment.

c. Metal structure:
1) Coordinate with the Architect to determine load bearing capacity of corrugated metal decks or similar materials.
2) Provide rigid attachment to the metal deck materials.
3) If deck materials are not capable of adequate support of the fixtures, install additional steel channels, angles, beams, or similar structural reinforcing materials to support the fixtures and their hanging mechanism.

3.3 EXIT AND EMERGENCY BALLASTED FIXTURES

A. Exit signs:
1. Exit signs shall generally be ceiling or wall mounted as indicated on the Drawings and Fixture Schedule or as required by the mounting surfaces and wall treatments.
2. The Contractor is responsible for verifying door schedules and room finishes to insure proper clearances from obstructions such as door openings.

B. Connect exit and emergency fixtures to:
1. Unswitched lighting circuit from exit switch or panel lock-on circuit breaker(s), or
2. Emergency powered panel branch circuit as noted on the Drawings.

C. Exit and emergency fixtures that are uncircuited on the Drawings shall be uniformly balanced between the available number of emergency/exit lighting circuits.

D. Minimum conductor size for all exit circuits is #10AWG.

E. Contractor may elect to leave emergency fixtures with charger/battery packs disconnected prior to the energization of the system to avoid complete discharge of the battery packs. Connect all fixtures prior to final inspection.

3.4 EXTERIOR LIGHTING FIXTURES

A. Connect fixture ballast to correct voltage tap. Install “wire nuts” or other suitable protection for any unused leads on multi-tap drivers.

B. Wall mounted fixtures:
1. Provide cast junction boxes for surface mounted fixtures.
2. Provide gaskets for recessed junction boxes.
3. Boxes shall be approved for either damp or wet location installation (as required).

C. Grade mounted fixtures with pole bases:
2. Refer to Division 3 for general specifications for concrete work.
3. Rest pole base sides and bottom against undisturbed earth.
4. Anchor bolts shall be furnished by the pole manufacturer.
5. Dimensions of concrete bases:
a. Refer to the Drawings for specifics on pole base dimensions.
b. Drawings indicate general dimensions of bases based on specified poles or general pole dimensions, as noted.
c. Contractor shall coordinate with actual pole dimensions to ensure that bases are of adequate size. Poured bases shall meet the following minimum width or diameter requirements:
   1) Where round concrete bases are designed, base diameter shall be at least 4" greater than the diagonal distance across the square pole base plate.
   2) Where square or tapered square concrete bases are specified, the horizontal base dimensions at the top of the base shall each be 4" greater than the side dimension of the base plate.
d. Verify all dimensions, anchor bolt patterns, or similar arrangements prior to any drilling or pouring of bases.

6. Distance of top of pole bases above final grade:
a. 4" above grade where mounted in landscape areas not subject to damage by traffic.
b. 12" above grade where mounted in landscape areas adjacent to parking lot sidewalks.
c. 30" above grade where mounted in areas subject to damage by traffic (such as parking lots).

7. Concrete pole bases poured with off-center anchor bolts, twisted bolts, incorrect dimensions, incorrect reinforcing bar positioning, conduits placed outside of pole opening, or similar deficiencies shall be removed in their entirety and replaced with correctly installed bases at the Contractor’s expense.

8. Arrange base conduits as closely as practical to allow all of conduit to be covered with the interior of the pole shaft.

9. Make all wiring joints accessible for connections at the pole handhole.

10. Ground pole through a driven ground rod installed inside of or adjacent to the concrete pole base. Connect grounding conductor to the branch circuit system ground, ground rod, and to the metallic pole or fixture body.

11. Setting of poles on concrete bases:
a. Set poles on concrete bases after bases are sufficiently cured.
b. Level pole by installing and adjusting nuts on both top and bottom of base plate.
c. Base plate shall not sit directly on the top of the concrete base, but shall instead be supported by the anchor bolts and nuts.
d. Tighten all nuts securely after leveling is completed.

12. Install and connect fuseholders and fuses.

13. Install and connect wiring inside pole from fuseholders to ballast in fixture head.

14. Conductors between the pole base branch circuit connection and the fixture ballast leads shall be a minimum of #12AWG unless approved otherwise. Include grounding conductor between base branch circuit and fixture housing.

15. Adjust lighting fixture for proper throw of light pattern. Refer to Drawings for orientation of fixtures. Confirm orientation at night.

D. Fuses:
1. Install in the following locations:
   a. For all pole mounted fixtures.
   b. For “wall-pack” type fixtures where scheduled on the Drawings to be provided with fuses.

2. Pole mounted fixtures requiring fuses:
   a. Fuses required:
      1) Provide one fuse per fixture for fixtures connected 120V or 277V.
      2) Provide two fuses per fixture for fixtures connected 208V, 240V, or 480V.
      3) See Section 26 28 16 for types of fuses required.
   b. Fuse holders:
      1) Install where accessible from the pole handhole or the stanchion junction box.
      2) Crimp line and load side of fuses to fuseholder.
      3) Install insulating boot over both line and load side conductors.
      4) Tape joint at each insulating boot with at least 4 layers of insulating electrical tape to seat the boot and prevent slippage down the conductor.
   c. Size fuses as follows:
      1) Approximately 150%-250% of maximum fixture current (during either starting or running conditions) if time delay fuses are used.
      2) Approximately 300% of maximum fixture current (during either starting or running conditions) if fast acting fuses are used.
      3) As recommended by fixture manufacturer if the manufacturer publishes the recommended fuse size.

3. Coordinate fuse and fuseholder installation in “wall-pack” fixtures to assure that fuses are provided by either the Contractor or the fixture manufacturer.

3.5 SPARE DRIVERS
   A. Provide spare drivers directly to the Owner at the completion of the project. Drivers shall be new and in the original boxes. Obtain a receipt from the Owner for delivery of the spare drivers to his care.
   B. Spare drivers are for Owner’s spare stock only and are not to be used by the Contractor for replacement of drivers installed in lighting fixtures on the project that are defective or have shortened lifetimes and require replacement during the warranty period.
   C. All drivers shall be the same as those provided in the particular fixtures furnished on the project.
   D. Provide the following spare drivers:
      1. Two drivers for each driver type installed on the project.
SECTION 26 53 00 - LAMPS AND LIGHT SOURCES

PART 1 - GENERAL
1.1 DESCRIPTION OF WORK
   A. Extent of Work as shown on the Drawings and described in these Specifications.

1.2 SUBMITTALS
   A. Submit manufacturer's data demonstrating compliance with these Specifications and the schedule on the Drawings in accordance with Section 26 05 00.

PART 2 - PRODUCTS
2.1 GENERAL REQUIREMENTS
   A. Refer to Drawings and Fixture Schedule for further details.

2.2 LIGHT EMITTING DIODE (LED) LIGHT SOURCES:
   A. LED light sources shall comply with the following general requirements. Refer to the Lighting Fixture Schedule on the Drawings for additional information.
   B. General requirements:
      1. See Lighting Fixture Schedule for minimum initial lumen output required for each LED product.
      2. Minimum lamp lifetime shall be 50,000 hours unless noted otherwise. LED lifetime shall be stated based on reaching L70 (70% of initial lighting output) as a minimum (L80 or L90 ratings are preferred).
      3. Luminous efficacy shall be 80 lumens per watt minimum.
      4. Color temperatures required are noted on the Lighting Fixture Schedule on the Drawings. In general, interior fixture temperature is 3,500 deg. K and exterior fixture temperature is 5,000 deg. K. Stated color temperatures shall be within a maximum of 2 MacAdam ellipses of each other.
      5. Color rendering index (CRI) shall not be less than 80.
      6. Drivers shall be integral with the display and designed for line voltage input with lower LED array output (voltage and nominal ampacity in milliams) as required to produce rated initial light output.

PART 3 - EXECUTION
3.1 GENERAL
   A. Furnish and install all lamps and lighting sources complete as herein specified and as called for in the Fixture Schedule on the Drawings.
   B. Clean all lamps and leave free of any dirt, dust, grease, etc., at the completion of the job.

END OF SECTION – 26 53 00
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rod electrodes.
   2. Wire.
   3. Mechanical connectors.
   4. Exothermic connections.

B. Related Sections:
   1. Section 03 30 00 – Cast in Place Concrete: Bonding or welding bars when reinforcing steel is used for electrodes.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
   1. Metal underground water pipe.
   2. Metal building frame.
   3. Concrete-encased electrode.
   4. Rod electrode.

1.4 SUBMITTALS

A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Product Data: Submit data on grounding electrodes and connections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Contract Closeout: Requirements for submittals.
B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.6 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Material and Equipment: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
   1. Copperweld, Inc.
   2. Erico, Inc.
   3. Substitutions: Section 01 60 00 – Material and Equipment.

B. Product Description:
   1. Material: Copper-clad steel
   2. Service Entrance Grounds: 3/4 inch diameter and 10 feet in length.
   3. Supplemental Ground Rods: 1/2 inch diameter and 6 feet in length.
   4. Pole Base Grounds: 1/2 inch diameter and 6 feet in length.
   5. Connector: Connector for exothermic welded connection.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 4 AWG.

C. Grounding Electrode Conductor: Copper conductor bare or insulated.

D. Bonding Conductor: Copper conductor bare or insulated.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
   1. Erico, Inc.
   2. Substitutions: Section 01 60 00 – Material and Equipment.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

A. Manufacturers:
   1. Cadweld, Erico, Inc.
   2. Substitutions: Section 01 60 00 – Material and Equipment.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.
PART 3 EXECUTION

3.1 EXAMINATION
   A. Section 01 50 00 – Construction Facilities and Temporary Controls: Verification of existing conditions before starting work.
   B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION
   A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.3 GENERAL INSTALLATION REQUIREMENTS
   A. Install in accordance with IEEE 142 and NEC Article 250.
   B. Install rod electrodes at locations as indicated on Drawings.
   C. Install grounding and bonding conductors concealed from view.
   D. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

3.4 RACEWAY GROUNDING CONDUCTORS
   A. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
   B. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panel boards with installed number 12 conductor to grounding bus.

3.5 GROUNDING CONNECTIONS
   A. Where noted on the Drawings, provide compression or exothermic weld connections to the building structural steel, ground grids, or to grounding rods.
   B. Either Burndy “HyGround” compression connection system or Cadweld exothermic welding system may be used for connection of copper conductors to copper conductors, or for connection of copper conductors to steel components.
   C. Follow manufacturer’s guidelines for installing all components of the system.

3.6 FIELD QUALITY CONTROL
   A. Perform ground resistance testing in accordance with IEEE 142.
   B. Perform continuity testing in accordance with IEEE 142.

END OF SECTION – 27 05 26
SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Conduit supports.
   2. Formed steel channel.
   4. Sleeves.
   5. Mechanical sleeve seals.
   6. Firestopping relating to electrical work.
   7. Firestopping accessories.
   8. Equipment bases and supports.

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.

1.2 REFERENCES
A. ASTM International:

B. FM Global:

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   5. UL - Fire Resistance Directory.

E. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 DEFINITIONS
A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION
A. Firestopping Materials: UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1.5 PERFORMANCE REQUIREMENTS
A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS
A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
F. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.
G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE
A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
1.8 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 – Material and Equipment: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS
A. Section 01 60 00 – Material and Equipment: Environmental conditions affecting products on site.
B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
D. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS
2.1 CONDUIT SUPPORTS
A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
D. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
E. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL
A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS
A. Product Description: Mounting hole and screw closure.

2.4 SLEEVES
A. Sleeves for conduit Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
B. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 FIRESTOPPING
A. Manufacturers:
   1. Dow Corning Corp..
   2. Hilti Corp.
   3. Substitutions: Section 01 60 00 – Material and Equipment
B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

PART 3 EXECUTION

3.1 EXAMINATION
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Verification of existing conditions before starting work.
B. Verify openings are ready to receive sleeves.
C. Verify openings are ready to receive firestopping.

3.2 PREPARATION
A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
B. Remove incompatible materials affecting bond.
C. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS
A. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide precast inserts, expansion anchors and preset inserts.
   2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
   3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
   5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
   7. Wood Elements: Provide wood screws.
B. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.
D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
E. Install multiple conduit runs on common hangers.
F. Supports:
   1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
   2. Install surface mounted cabinets and panelboards with minimum of four anchors.
   3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.

3.4 INSTALLATION - FIRESTOPPING
A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS
A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

3.6 INSTALLATION - SLEEVES
A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
C. Set sleeves in position in forms. Provide reinforcing around sleeves.
D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

3.7 FIELD QUALITY CONTROL
A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING
A. Section 01 70 00 – Contract Closeout: Requirements for cleaning.
B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK
A. Section 01 70 00 – Contract Closeout: Requirements for protecting finished Work.
B. Protect adjacent surfaces from damage by material installation.

END OF SECTION – 28 05 29
PART 1 GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
   2. 

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.4 SUBMITTALS

A. Section 01 30 00 - Submittals: Submittal procedures.

B. Product Data: Submit for the following:
   1. Flexible metal conduit.
   2. Liquidtight flexible metal conduit.
   3. Nonmetallic conduit.
   4. Flexible nonmetallic conduit.
   5. Nonmetallic tubing.
   6. Raceway fittings.
   7. Conduit bodies.
   8. Surface raceway.
   9. Wireway.
   10. Pull and junction boxes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC conduit from sunlight.

1.6 COORDINATION

A. Section 01500 – Construction Facilities and Temporary Controls: Coordination and project conditions.
B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. Alflex.

B. Product Description:
   1. Usage restrictions:
      a. As per NEC Article 348.
      b. Flexible metallic conduit shall not be used as the general wiring system.
      c. The Engineer shall be consulted on all questions regarding the use of flexible conduit and shall interpret the intent of the Specifications regarding the locations for which flexible conduit is allowed.
   2. Approved for general use in the following situations or locations:
      a. Interwiring of millwork and cabinets for feeds to outlet boxes.
      b. Locations where equipment, ductwork, structure, or other hindrance makes it impractical or impossible to install straight or offset tubing or conduit. This provision does not provide for the use of flexible conduit where improper prior planning or delay in conduit installation make the location subsequently inconvenient for the use of straight or offset runs of conduit or tubing.
   3. The use of flexible conduit in old work is extended to include installation of conduits fished in existing walls or other special or unusual situations approved by the Engineer.
   5. Used with fittings specifically approved for use with flex.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. LTV Steel Tubular Products.
   2. Allied Tube and Conduit.

B. Product Description:
   1. Usage restrictions per NEC.
   2. Used for above-grade wiring only. EMT is not permitted in slabs or below grade.
   3. Used to enclose:
      a. Communications wiring or cabling.
      b. Control wiring.
      c. Similar types of wiring unless noted otherwise in the specifications or on the Drawings.
   4. Galvanized mild strip steel with interior UL approved coating.
   5. Fittings:
      a. The following types of fittings, couplings, and connectors may be used:
         1) Die-cast non-insulated zinc compression type.
         2) Steel non-insulated compression type.
         3) Conduits trade size 1-1/4” and smaller may have set screw fittings where used in dry interior locations only if the circuit contains a separate grounding conductor.
b. The following types of fittings, couplings, and connectors are prohibited:
   1) Expanded conduit ends with factory pre-installed set-screw attachments.
   2) Indentor type.
   3) Set-screw type.

2.3 NONMETALLIC RIGID CONDUIT (PVC)

A. Manufacturers:
   1. Carlon Electrical Products.
   2. Can-Tex.

B. Product Description:
   1. Usage restrictions per NEC Article 352
   2. General requirements:
      a. Polyvinyl chloride compound.
      b. Schedule 40-wall thickness.
      c. Flame retardant type.
      d. Resistant to bending and cracking.
      e. UV resistant.
   3. Used for horizontal runs of underslab or underground conduits. Vertical risers and all ells installed below grade must be rigid steel installed as noted previously.
   4. No above ground installation.
   5. Couplings and fitting designed for permanent glued connection to the conduit.

2.4 INTERIOR OUTLET AND JUNCTION BOXES

A. Manufacturers:
   1. Steel City.
   2. Raco.
   3. Appleton.

B. Standard interior outlet boxes for connection to concealed conduit raceways, or for exposed surface mounted conduit raceways in mechanical spaces, electrical rooms, and similar non-public areas:
   1. General requirements:
      a. Of proper size and shape for conduits and conductors entering them.
      b. UL and NEC listed for their application.
      c. Constructed of code gauge steel.
      d. Galvanized or plated.
      e. Complete with conduit knockouts (boxes 4” square and smaller).
   2. A minimum of 1-1/2” deep unless the following conditions are met:
      a. Construction requires a smaller depth box.
      b. Engineer specifically approves the use of such shallow boxes.
      c. Depth is not reduced below 1-1/4”.
   3. Box construction:
      a. Formed (drawn) one piece, for single gang boxes.
      b. Formed (drawn) one piece or stamped and welded for double gang boxes.
      c. Formed (drawn), stamped and welded, or sectional type for boxes greater than 2 gang.
d. Masonry type stamped and welded boxes (with continuous overlapping device screw attachment trim) may be used where recessed in concrete or concrete block (CMU) wall construction.

4. Box size:
   a. 4” square for up to two devices and solid ganged boxes for over two devices.
   b. Single gang “handy boxes” may be used for device boxes in limited areas (such cabinet work) only with the Engineer’s permission. Do not use bevel corner boxes.
   c. 4-11/16” square boxes for specific devices (such as fire alarm equipment) where required. Consult with manufacturer to determine use and location of special boxes.

C. Standard interior outlet boxes for connection to surface mounted two piece raceway systems:
   1. Stamped enamel painted steel.
   2. Of proper size and shape for surface raceways and conductors entering them.
   3. UL and NEC listed for their application.
   4. A minimum of 1-1/2” deep unless a shallower device box is approved.
   5. Single gang unless used for two devices.

D. Interior junction boxes mounted above the ceiling line for connection and distribution of branch circuit wiring to receptacles, lighting fixtures, and small motor loads shall be of the same type as standard 4” square outlet boxes except that they shall have flat steel covers.

2.5 CAST BOXES

A. Manufacturers:
   2. Appleton.

B. Where specified on the Drawings or required for surface mounted exterior or wet interior locations, provide cast outlet boxes.

C. Cast outlet box standards:
   1. Threaded hub type with drilled mounting lugs.
   2. Constructed of ferrous (malleable iron) alloy.
   3. Equal to Crouse-Hinds “Condulet” or Appleton “Unilet” type. Fixture outlet boxes equal to type VFX or GRF type; wiring device outlet boxes equal to type FS or FD.
   4. Provide with plugs for all unused openings, gaskets, and covers compatible with the function of the box.
   5. Where required to be coated for corrosion resistance, provide as follows:
      a. Permanently fused to galvanized surface. Coatings that require the galvanized surface to be compromised prior to application of the coating are not acceptable.
      b. Smooth and continuous.
      c. Comply with NEMA RN1 and applicable ASTM standards for immersion in boiling water and application of humidity and acetone.
      d. Exterior coating:
         1) Field strippable.
         2) Nominal 40-mil thickness of polyvinyl chloride (PVC).
         3) Applied after the surface has been primed to receive the coating.
e. Interior coating:
   1) Permanently coated.
   2) Nominal 2-mil thickness of polyurethane.
   3) Resistant to abrasion from pulling of conductors through conduit.

2.6 PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Hoffman.
   2. Wiegmann.
   3. Milbank.

B. Install:
   1. Where noted on the Drawings.
   2. Where the total number of bends exceeds 360 degrees.
   3. At other locations required by the NEC.

C. Use boxes constructed of code gauge steel with standard size knockouts or suitable for field drilling.

D. Provide junction or pull boxes required by the Drawings or by codes larger than the standard 4" square where required.

2.7 EXTERIOR GRADE PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Strongwell Quazite.
   2. Newbasis.
   3. Carson.

B. Provide where required for termination and intermediate pulling access.

C. General requirements:
   1. Polymer cast concrete construction reinforced with fiberglass. Plastic construction is not acceptable.
   2. Designed for flush grade mounting.
   3. Solid wall construction without knockouts unless approved otherwise.
   4. Load ratings:
      a. General Duty UL Tier 5 for grassy and pedestrian traffic areas.
      b. Heavy Duty UL Tier 10 for sidewalks, driveways, and similar areas accessible to vehicular traffic.
   5. Lid:
      a. Single or two-piece.
      b. Attached with stainless recessed head bolts.
      c. Logo as directed, molded into top of lid.
   6. Bottom:
      a. Provide bottom in box where noted.
      b. Provide open bottom if not noted.
   7. See Drawings for sizes required.
2.8  FIRE SEALING REQUIREMENTS

A. All electrical penetrations through fire rated walls, floors, and ceilings shall be fire sealed to prevent the propagation of smoke and fire, regardless of whether they are enclosed by a raceway or not.

B. Provide fire sealing in all locations required by applicable Codes.

C. Utilize materials suitable for the intended service.

D. Fire sealing shall be provided for both raceway and free-wired low voltage cabling through firewalls or fire barriers.

E. Generally required UL ratings:
   1. Floors:
      a. Utilize FA rating for concrete floors less than 5 inches thick.
      b. Utilize FB rating for concrete floors more than 5 inches thick.
      c. Utilize FC for wood framed floors.
   2. Walls:
      a. Utilize WL rating for framed walls.
      b. Utilize WJ rating for concrete or masonry walls less than 8 inches thick.
      c. Utilize WK ratings for concrete or masonry walls more than 8 inches thick.

F. Putties and sealants:
   1. Utilize for openings of less than 6 inches in diameter.
   2. Generally preferred method for sealing conduit penetrations through walls, ceilings, and floors.
   3. May be manufactured in caulk tubes, sticks, buckets, or similar manner to allow easy field insertion for fire stopping.
   4. Communication wiring and similar seals must remain permanently soft to allow reuse and re-entry into the sealed opening. Seals for permanent conduit penetrations may become hard after installation.
   5. Do not use materials that give off toxic fumes when curing.
   6. UL listed for the same rating as the wall the raceway penetrates (typically 1 or 2 hours).

G. Pipe wrap:
   1. Utilize for conduit penetrations of walls, floors, and ceilings.
   2. May be used instead of putties and sealants where approved by the Engineer.
   3. Intumescent type that expands upon being heated.

H. Floor-to-floor conduit sleeves:
   1. Provide rigid steel conduit sleeves where installed for upper wood or precast concrete tee floors.
   2. Provide fire stop assembly for cast-in-place applications where above grade concrete floors are poured in place on site. Assembly requirements:
      a. Plastic sleeve with integral rubber gasket and intumescent ring of fire stopping material to provide both fire and smoke sealing.
      b. Top plug to exclude concrete during pouring of slab and dust and dirt after installation is completed.
      c. Suitable for replacement of conduit once installed without replacement of assembly.
      d. Suitable for use in floors between 2.5” and 6” of thickness.
      e. Resistance to normal temperatures up to 100 deg. C.
      f. Equal to Hilti CP 680 series.
2.9 CORROSION PROTECTIVE TAPE

A. General requirements:
   1. Use for any metallic conduit installed in concrete or below grade.
   2. Pressure sensitive PVC based type suitable for direct burial applications.
   3. Impact resistant
   4. Resistant to moisture, acids, salt, and alkalis.

B. Equal to Scotch #50 or #51.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 FIRE SEALING REQUIREMENTS

A. Install fire sealing in all locations required by applicable Codes.

B. Fire sealing shall be installed for all raceway and sleeve penetrations of fire rated walls, ceilings, or floors above grade.

C. Fire sealing shall consist of fire rated putty, sealants, boards, poured or sprayed materials, pillows, or sheets of fire sealing material of required sizes and quantities to completely and effectively seal the associated fire barriers.

D. Wall penetrations of conduit shall generally be sealed with putty or caulk type sealant. Thoroughly seal penetration to avoid any air spaces around the wall penetrations.

E. Floor penetrations shall be sealed as follows:
   1. For wood floors and pre-cast steel concrete tees:
      a. Install rigid steel nipple through concrete floor. Stub both above and below floor line approximately 1 inch.
      b. Securely attach nipple with pipe clamps or other suitable method to prevent nipple from shifting.
      c. Pack between nipple and concrete opening with ceramic fiber or mineral wool for areas not requiring fire-stopping putty.
      d. Install fire-stopping putty at top and bottom of penetration. Thickness shall be as recommended by manufacturer.
   2. For cast-in-place concrete floor and concrete floors above metal decks with total floor thickness between 2.5” and 6.0” with dimensions of sleeves up to 4” in diameter.
      a. Provide pre-manufactured firestop assembly instead of field fabrication method noted previously.
      b. Assembly shall be Hilti #CP 680 series or other approved by the Engineer.
      c. For total concrete construction:
         1) Attach bottom flange to bottom floor form with top of shaft above top of concrete pour.
         2) Close all openings with temporary plugs.
         3) Support assembly prior to pour to prevent movement.
         4) After floor is poured, cut off top of assembly flush with floor line and re-insert top plug.
      d. For concrete topping slab installed on top of metal decking:
1) Cut circular hole through decking and install metal deck adapter for assembly.
2) Attach bottom flange of assembly to deck adapter and to screw bottom flange to deck. Place with top of assembly shaft above top of concrete pour.
3) Close all openings with temporary plugs.
4) Support assembly prior to pour to prevent movement.
5) After floor is poured, cut off top of assembly flush with floor line and re-insert top plug.

F. Install all fire seal materials in accordance with manufacturer’s recommendations and NEC Article 300-21.

3.3 INSTALLATION- RACEWAY

A. Install all wiring in NEC approved raceways (unless specifically approved otherwise) sized as shown on the Drawings, or, if not sized on the Drawings, in accordance with NEC conduit fill tables.

B. Install raceway systems in a neat, straight, and workmanlike manner complete with all J-boxes and pull boxes as necessary or noted on plans.

C. Raceway general installation notes:
   1. All raceways are to be concealed unless noted or approved otherwise.
   2. Run concealed conduits as follows:
      a. Straight and parallel to building lines where installed in walls and above ceiling lines.
      b. In a direct line (unless interferences with other trades prevent) where installed under slabs or below grade.
      c. Do not run conduit horizontally in concrete block (CMU) walls, whether cells are filled or unfilled. Conduits must run vertically inside the CMU cells and be fed from overhead or underground, as appropriate.

D. Mechanical details of conduit and raceway installation:
1. Make all cuts squarely, ram after cutting, and butt conduits solidly into fittings.
2. All conduit and raceway systems must be mechanically continuous and installed complete before conductors are pulled.
3. Bend conduit with approved bending devices. Remove and replace deformed or damaged conduit.
4. Temporarily plug opening if conductors are not immediately installed in the raceway. Install plugs to exclude plaster or other foreign materials.

E. When a metallic conduit enters an enclosure, provide an insulated throat connector and or an insulating bushing where the conduit contains conductors sized #4AWG or larger.

F. Do not run conduit or raceway adjacent to steam piping or hot vent piping unless authorization is provided.

G. Sleeves:
1. Install where noted on the Drawings.
2. Provide for conduit entrances into exterior building walls below grade as follows:
   a. Provide steel conduit sleeves, cutouts, chases or knockouts for passage of the raceways through the exterior wall(s).
   b. Sleeves or knockouts shall be of adequate size to allow for reasonable settlement or movement of the raceway or building wall without damage to the enclosed conduits and wiring.
   c. Completely seal all sleeves, chases, or knockouts to prevent moisture from entering basement areas or from migrating under footings.
   d. Steel sleeves significantly larger than the enclosed conduit shall have a steel plate welded to the exterior of the sleeve to properly close the wall opening prior to waterproofing.
   e. Consult the Engineer for determination of specific problem resolution which may include special construction.

3.4 INSTALLATION - UNDERGROUD RACEWAY

A. Carefully plan excavations for electrical systems and utilities in advance, paying particular attention to other utilities in the project area, both existing and new. Use hand and/or machine excavation cautiously to prevent damage to installed systems. The Contractor is responsible for repairing all damages caused as a result of excavation.

B. Standard conduit depths:
1. Slightly less than 60” deep for utility primary cables and conduits where ditching is provided by the Contractor.
2. Minimum of 36” below grade outside of the building lines for service entrance and feeder circuits.
3. Minimum of 24” below grade outside of the building lines for branch circuit conduits.
4. Below concrete building slabs:
   a. Conduits installed under sidewalks, driveways, porches, and similar areas outside of the main building slab shall maintain the minimum depths listed above.
   b. Conduit installed under the main building slab:
      1) Do not install horizontal conduit runs in the slab itself.
      2) Place conduit in sand cushion region below the building slab or place in the lower soil below the sand cushion.
      3) Conduits placed in the lower soil shall have their surrounding ditch area filled with compacted sand with the bottom of the conduit placed at least 1” above the bottom of the ditch soil.
4) Adjust conduit depth so there is adequate room to turn up risers so that risers are vertical after passing through the top surface of the slab.

C. Ditch backfill:
   1. Backfill with “flowable fill”:
      a. Flowable fill shall contain Portland cement, water, fly ash, and fin aggregate.
      b. Portland cement:
         1) Mix shall contain a minimum of 3.5 sacks of Portland cement per cubic yard of fill.
         2) Type I or type II conforming to ASTM C150 or ASTM C595.
      c. Fly ash shall conform to ASTM C618 Class C or Class F. Fly ash may be eliminated only with written approval of the Engineer.
      d. Batching and mixing shall conform to ASTM C94. Place with chutes, conveyors, or pumps.
      e. Flowable fill shall “flow” with little head or mounding, with a slump of approximately 10” to 11”.
      f. 28-day compressive strength shall be no more than 100 psi and no less than 75 psi.
      g. Depth of flowable fill:
         1) Asphalted areas: Entire ditch depth except for within 7.5” of final grade.
         2) Grassy areas. Entire ditch depth except for within 12” of final grade.

D. Tracer wire:
   1. Provide and install in conduit ditches for spare or unused conduits.
   2. Install one #12AWG solid copper THHN/THWN insulated conductor in the ditch with the conduit.
   3. Temporarily attach the tracer wire to the outer top surface of the conduit to keep the tracer wire from falling off of the conduit and into the ditch prior to backfilling. Utilize electrical tape, duct tape, or similar material for attachment of tracer wire.
   4. Stub up tracer wire above grade on each end of conduit run as the conduit penetrates grade level. Provide loop of wire at each end to allow for future easy attachment of tracer equipment. Attach wire loops to sides of conduit.
   5. Internal pull wire may not be substituted for tracer wire.
   6. Tracer wire is required outside of the building slab perimeter for non-metallic conduits only under the following conditions:
      a. Empty service entrance and feeder non-metallic conduits installed without conductors and in a direction other than that of other service entrance of feeder conduits (spare or empty conduits run with active conduits do not require tracer wires).
      b. Active or inactive conduits for fiber optic cables.
      c.

E. Ditch marking tape:
   1. Install in the ditch where utility or service entrance conduits are buried outside the building perimeter.
   2. Tape is not required for exterior branch circuit ditches.
   3. Install approximately 6” to 12” below final grade.
   4. Tape requirements:
a. Equal to 6 ply extra stretch “Terra-Tape 540” manufactured by Reef Industries, Inc.
b. Nominally 6” wide.
c. Yellow or red background with black block letters continuously printed with the statement “Caution Electric Line Buried Below” or similar acceptable wording.

3.5 INSTALLATION- PVC RACEWAY

A. Joints:
1. Thoroughly clean conduit and fitting or coupling prior to application of glue.
2. Utilize solvent type glue compound, which will provide a watertight permanent joint by welding both PVC surfaces together.
3. Do not use aerosol or spray-on joint compound.

B. Bends and offsets:
1. Make any PVC field offsets with a hot box bender specifically approved for the purpose.
2. PVC offsets of less than 45 degrees may be field or factory made.
3. Install factory PVC bend where angle of bend is 45 degrees or more.
4. Provide rigid steel or IMC factory ell or offset in conduit run, instead of PVC, where:
   a. Conduits 2” trade size or larger.
   b. Length of run exceeds 125 ft.
   c. Ropes larger than ¼” diameter are used for pulling conductors.
   d. Any location where the installation of the conductors may pull through the interior wall of PVC elbows or offsets.

C. Transition to the type of metallic conduit used above grade or above slab as the PVC conduit passes through the grade or slab.

D. Protection of steel fittings, couplings, elbows, and offsets utilized below grade in PVC conduit runs:
1. Protect metallic conduit and fittings with either factory-applied coating or field applied coating.
2. Coatings or fitting skirts shall extend past the metallic conduit or fittings onto the PVC conduit run to make a watertight seal.
3. Field applied tape coatings:
   a. Overall coating must be a minimum of 20 mils thickness.
   b. Provide at least one half-lapped layer of Scotch #50 (10 mil) tape or one layer of Scotch #51 (20 mil) tape with overlapped edges.
   c. Prime conduit with Scotch Pipe Primer (or equal) prior to application of tape.

3.6 INSTALLATION- HDPE RACEWAY

A. Lay the conduit in the ditch as straight as possible, taking care to avoid “snaking” of conduit.

B. Conduit shall be installed complete, end-to-end, without joints in the HDPE run. If conduit installed is too short, replace with single continuous run.

C. Take precautions to avoid deforming the internal diameter of the conduit. Any conduit which is kinked or has excess “ovaling” shall be removed and replaced.

D. Provide couplers where transitioning from HDPE to PVC or steel conduit. Coupler installation:
1. Thoroughly clean conduit and fitting or coupling prior to application of couplers.
2. Prepare cut conduit ends by beveling the outside edge of the conduit prior to inserting into the coupler.
3. Remove any stray burrs or conduit shavings with a deburring tool.
4. Install coupler onto conduits at the correct docking depth. Tighten stainless steel bands to provide a watertight joint.

E. Transition to the type of metallic conduit used above grade or above slab before the HDPE conduit passes through the grade or slab. HDPE may be run complete without transition only where the conduit terminates in a poured concrete base (such as a pole base).

3.7 GENERAL INSTALLATION – BOXES
A. Refer to the Drawings for the general location of boxes and outlets.
B. Switch boxes near doors:
   1. Install close to trim when located by doors.
   2. Place wall switch outlets at door locations on the lock side of the door. If no usable wall space adjacent to the lock side jamb is available, place switch outlets on the wall against which the door swings and in a location accessible after the door is fully opened.
C. Boxes required by code due to conduit bends are generally not indicated on the Drawings.
D. The Contractor shall familiarize himself with the details of all rooms, spaces, and construction requirements so that the installation of outlets and other electrical equipment shall not interfere with work of other trades or render the outlets or equipment inaccessible for maintenance or repair.
E. Any outlet, box, or related item may be relocated within 10 feet of its indicated location without additional cost to others.
F. General Requirements:
   1. Close unused openings with knock-out closures.
   2. Properly support to prevent movement.
   3. Reduced in size if necessary when indicated to be installed in window mullions or other areas requiring narrower or smaller boxes. Substitutions require the Engineer’s approval.

3.8 INSTALLATION – WALL OUTLET BOXES
A. Offset to reduce sound transmission between rooms.
B. Outlet boxes in smoke control walls (such as egress corridor walls) shall be offset at least 24” from each other where mounted on opposite side of the wall. If smoke control wall outlet boxes are not placed at least 24” apart, then the rear of the box shall be covered with a fire rated pad (such as “Metacaulk Box Guard”) which will expand and seal off the box in the event of a fire, or must be completely covered with a fire rated putty along the top, bottom, and sides of the box.
C. If new switches, receptacles, or similar devices are installed in existing outlet boxes, the following shall be provided:
   1. Existing outlet boxes must be of sufficient size to accommodate new devices.
   2. Existing outlet boxes must be of correct heights to conform with ADA and similar code heights. See subsequent information for correct mounting heights. Existing boxes that do not meet the new mounting height requirements shall not be reused for new devices or shall be moved to the new correct mounting heights.
3.9 INSTALLATION – RECESSED BOXES
A. Install so that device and/or coverplates shall be tight and plumb with wall finish.
B. Box supports are required of all interior switch and receptacle boxes unless excluded by the Engineer.
C. Install with device box supports equal to Caddy “H” series “Quick-mount” for interior use.
D. Boxes installed masonry walls may use the mortar fill or block sides to support the boxes provided the fill or sides are in close contact with the boxes and permanently prevent movement.
E. Ganging boxes:
   1. Gang where possible.
   2. Where interior multiple receptacle, switch, or communication outlets are indicated on the Drawings, boxes to be closely grouped, use Caddy “SGB” series of box brackets.
   3. Do not widely space outlets indicated on the Drawings to be grouped.
F. Covers and rings:
   1. Cover with ½” raised galvanized device covers for exposed conduit work.
   2. Furnish with raised galvanized plaster rings for concealed conduit work.
   3. Provide single gang rings for single device mounts even if box is double gang.

3.10 INSTALLATION – CEILING BOXES
A. Install so that device and/or coverplates shall be tight and plumb with ceiling line or tight to exposed structural mounting.
B. Furnish with raised galvanized plaster rings for concealed box installation in plaster, wood, or gypboard ceilings.
C. Furnish 4” square or octagonal 4” nominal sized boxes for connecting to standard fixtures.
D. Structurally support boxes used for hanging lighting fixtures or other items in accordance with the Drawings and NEC Articles 410.

3.11 INSTALLATION – BOX MOUNTING HEIGHTS
A. Mounting heights of outlets: The height of each outlet shall be in accordance with the Specifications and as directed by Architect for special décor or other architectural features. Heights are given above finished floor to the center of the outlet box unless noted otherwise.
B. Standard Mounting Heights:
   1. Wall switches 48”
   2. Receptacles—General use 15”-18” (*1)
   3. Receptacles—Storage 24”
   4. Receptacles—Cabinet work Above splash
   5. Receptacles—Sinks Above lip of sink
   6. Desk Telephone/Data 15”-18” (*1)
   7. Disconnect Switches 48”-60”
   8. Receptacles in Service areas 24”

(*1) Locate outlet boxes as follows:
   a. Minimum height of receptacles and communication outlets is 15”. This minimum height is for the lowest operable part of the receptacle, and reflects the final height after all floor finishes (such as carpet) have been
installed. For vertically mounted duplex wall outlets, this places the center of the box at no less than 16.5” AFF assuming vinyl tile (carpet or thicker floor covering will increase this height).

b. Outlets in close proximity to each other shall be set at the same height to satisfy the most restrictive condition so as to avoid a staggered appearance.

3.13 CLEANING

C. Section 01 70 00 – Contract Closeout: Final cleaning.

D. Clean interior of boxes to remove dust, debris, and other material.

E. Clean exposed surfaces and restore finish.

END OF SECTION – 27 05 33
PART 1 GENERAL

1.1 SUMMARY

A. This section describes the work and equipment required to furnish and install the following:
   1. An in-house telephone and data cable raceway system, including outlet boxes and conduit.
   2. A complete in-house telephone and data cable system, including wiring, cabling, outlet jacks, punch down blocks, and similar items.

B. All switching units, desk or wall instruments, servers, routers, hubs, and similar items will be furnished and installed by others.

C. Telephone cables shall be Category 6 and data cables shall be Category 6. Cable TV cables shall be Category 6 or coaxial cable as indicated on the drawings. Telephone system will presently operate for digital voice traffic except for analog outlets as noted on plans. Coordinate termination requirements with owner.

1.2 SUBMITTALS

A. Section 01330 – Submittal Procedures: Submittal procedures.

B. Provide a submittal at the completion of the project to verify that all cabling requiring testing was field tested after installation and complies with the standards noted herein.

PART 2 PRODUCTS

2.1 MATERIALS

A. Manufacturers:
   1. Raceways: See Section 270533.
   2. Copper telephone and data cables:
      a. Panduit.
      b. Substitution not permitted.
   3. Category 6 components:
      a. Panduit.
      b. Substitution not permitted.

2.2 RACEWAY AND OUTLET SYSTEMS

A. Refer to Section 270533 for general details on the types and installation of raceways and conduit systems.

B. Conduit:
   1. In-house distribution conduits:
      a. EMT for above grade distribution conduits.
      b. Flexible steel only where approved by Engineer in cabinet work or similar locations.
      c. Conduits shall serve only one telephone or data outlet and shall not be “daisy-chained” between outlets.
      d. A complete conduit enclosed wiring system is not required and shall be run:
1) In non-return air plenums from the outlet box to the above accessible ceiling space.

2) To adjacent accessible ceiling space if ceiling material is plaster, gypboard, or other inaccessible surface.

3) In return air plenums from the outlet box full length to the terminal board unless plenum rated cable is used.

e. **Install a full length pull wire or pull tape in all conduits not presently receiving wiring or cabling.**

f. **Provide conduit to outlet boxes as follows:**

1) One ¾” conduit to each outlet designated as a telephone or data outlet.

2) Two ¾” conduits to each outlet designated as a combination data and telephone outlet.

**C. Outlet boxes:**

1. **Size:**

   a. Standard size is 4” square.

   b. Single gang boxes may be provided in limited space locations such as cabinet work, but only with the Engineer’s permission.

   c. **Plaster rings:**

      1) Provide single gang plaster rings for outlets designated as telephone or data outlet, or for a combination of telephone and data outlet.

      2) Provide double gang plaster rings for outlets designated as combination telephone and data outlets that have more than 4 sets of cable terminations.

   d. Combine data and telephone outlets into a single box where practical, including locations where separate boxes are indicated on the Drawings as adjacent to each other.

   e. **Outlet plates:**

      1) If a conduit only system is provided, install blank plates in all locations in which the Owner does not provide his own data or telephone plates.

      2) **Plates with jacks:**

         a) Plates shall be nylon type construction to match or be similar to receptacles plates.

         b) Plate color shall match color of receptacles in same area of room.

         c) All plates shall be modular type with inserts for a minimum of 4 jack positions.

         d) Telephone outlet wired with Category 6 cable: RJ-11 6 wire modular jack. Provide rear punch-down connecting block.

         e) Copper data outlet: RJ-45 8 wire EIA 568A or 568B (as directed) modular jack. Provide rear punch-down connecting block.

**2.3 COPPER CABLES AND WIRING**

A. **Telephone and data wiring general requirements:**

   1. Unshielded twisted pair (UTP).

   2. Solid copper conductors.
3. Individually inserted conductors per industry standard telephone type color coding.
4. Unfilled with overall insulating jacket as follows:
   a. PVC where installed in conduit full length or where installed in non-air return plenums.
   b. Teflon or other approved plenum rated cable insulation when installed in return air plenums.
5. Meet the following standard and codes:
   a. UL Subject 444.
   b. NEC Article 800.

B. Telephone cables (Category 6):
   1. For present analog voice traffic.
   2. Requirements:
      a. Tested and certified to comply with the requirements of EIA/TIA Category 6 transmission.
      b. Four twisted pairs of #23AWG conductors.
      c. White colored jacket.
      d. Nominal 100 ohm unshielded.

C. Data cables (Category 6):
   1. For data traffic.
   2. Requirements:
      a. Tested and certified to comply with the requirements of EIA/TIA Category 6 transmission.
      b. Four twisted pairs of #23AWG conductors.
      c. Blue colored jacket.
      d. Nominal 100 ohm unshielded.

D. Video cables (Category 6):
   1. For video system traffic.
   2. Provide coaxial cable for Cable TV systems where indicated on drawings in lieu of Category 6 cables. Refer to the drawings for individual school system details.
   3. Requirements:
      a. Tested and certified to comply with the requirements of EIA/TIA Category 6 transmission.
      b. Four twisted pairs of #23AWG conductors.
      c. Orange and white colored jacketes.
      d. Nominal 100 ohm unshielded.

E. PA System Cables (Category 6):
   1. For PA system traffic.
   2. Requirements:
      a. Tested and certified to comply with the requirements of EIA/TIA Category 6 transmission.
      b. Four twisted pairs of #23AWG conductors.
      c. Yellow colored jacket.
      d. Nominal 100 ohm unshielded.
PART 3 EXECUTION

3.1 INSTALLER QUALIFICATIONS

A. Only Panduit certified contractors are allowed to install data and phone systems on this project. A warranty must be provided. Unless approved otherwise by the Engineer or Owner, the installers shall be certified in the installation of communication systems.

3.2 RACEWAYS

A. Install in-house telephone and data raceway systems, including conduit, cable trays where noted, junction boxes, outlet boxes, and plates.

B. Provide pull wires in all raceways not currently receiving conductors.

3.3 CABLING SYSTEMS

A. Install in-house telephone and data wiring system including:
   1. Telephone and data wiring.
   2. Jacks and connectors.
   3. Punch-down blocks.

B. Telephone and data cable runs:
   1. Install complete without splice in a “star” pattern between outlet and source termination point.
   2. Distance shall not exceed 90 meters for Category 6 cabling. Contact Engineer if potential lengths will exceed this maximum distance.
   3. Conduit or raceways:
      a. Install in conduit inside walls and across fire or smoke barriers.
      b. Install in conduit or cable trays above ceilings where notes on the Drawings or in these Specifications.

   4. Pulling tension and bends:
      a. Do not exceed the manufacturer’s recommended pulling tension.
      b. Cable bend radius shall not exceed 4 times the cable diameter for copper cables and shall not exceed 15 times the cable diameter for fiber optic cables.
      c. Avoid excessive stress, strain, or bending of cables.
      d. Kinked cable shall be regarded as damaged and replaced full length.
      e. Provide extra slack near all termination points.

   5. Installation of cables without conduit above ceiling lines:
      a. Coordinate with HVAC system installation to insure that cables installed in all areas with free air return are either installed within metallic conduit or are provided with plenum rated insulation.
      b. Route copper cabling at least 12” from fluorescent or HID lighting fixtures, 6” from power circuits, and 24” from transformers and motors.
      c. Space supports 48” to 60” apart.
      d. Utilize “J” hooks with wide surface plastic saddles for cable support.
      e. Do not support cables with tie wraps or brindle rings.
      f. Any tie wraps used to secure cables to “J” hooks shall be plenum rated where the cable insulation is required to be plenum rated.
      g. Do not support cables from suspended ceiling support wires unless the ceiling supports are specifically rated for such use (ref. NEC 300-11) or if support wires are provided separately from ceiling grid supports.

C. Cable terminations:
1. Terminal boards:
   a. Mount punch-down blocks. Provide adequate number of punch-down blocks to terminate all trunk cables and a similar number of house floor cables.
   b. Provide wire management rings or similar equipment for a neat and finished installation.
   c. Punch down house wiring cable terminations.
   d. Cross-connect wiring will be provided and installed by others.
2. Jacks:
   b. Terminate copper data cables on RJ-45 EIA568B modular snap-in jacks installed in outlet plates.
   c. Telephone and data copper cables may utilize a common outlet plate.
   d. Provide space for marking the termination as to cable identification.
3. Terminations for Category 6 cabling:
   a. Do not remove more than 1” of cable insulation at termination point.
   b. Keep conductors twisted within ½” of the termination point at racks, terminal boards, and outlets.
   c. For data cables, determine after consultation with the Owner if EIA 568A or 568B termination sequence is required. If the Owner has no standard termination sequence, utilize EIA 568B.

D. Cable identification:
1. Identify each cable termination at the punchdown block or patch panel with proper types of machine-printed labels indicating location, cable type, and/or other appropriate designation.
2. Each room wall plate shall be clearly labeled on the wall plate and should read in the following format:
   a. #/ [MH-#], [R], [PP], [PPP]
      1) #/ = Room port number i.e. 1, 2, 3, 4…
      2) HH = Heritage Hills Elementary School
      3) SC = Spring Canyon Elementary School
      4) # = Number of MDF or IDF
         a) MDF will always be 1
         b) IDF need to be clearly marked on Drawings and not simply say “Data Closet”
         c) R = Rack Number
         d) PP = Patch Panel Identifier
         e) PPP = Patch Panel Port Number
   b. Example:
      1) Room Port Number 3/, IDF 2, Rack 1, Patch Panel 2, Port 23
      2) 3/MH-2, 1, 2, 23
      3) On the classroom side, the cable needs to have the same label on the cables as well as the wall plate.
3. Data Closet:
   a. Each patch panel label to have the Room number/Room port number
   b. Example:
      1) Room 223, Room Port 3
      2) 223/3
3) Label shall be on both the patch panel and on the cable going to the room.

4. Cable labels:
   a. Wrap-around type installed on the cable within 6-12” of its termination, where visible in outlet boxes.
   b. The same labeling shall be utilized for both source and end side of each cable.

E. Cable testing:
1. All copper cabling shall be initially tested for:
   a. Continuity.
   b. Correct labeling.
2. Functional wiring testing for copper UTP cables:
   a. Test for shorts.
   b. Test for proper pin-out and reversed pairs (wiremap).
   c. Utilize a broad frequency test instrument to insure proper operation as follows:
      1) Up to 250MHz for Category 6.
   d. Testing of UTP cables shall be in accordance with EIA/TIA568B.2.
   e. Test for:
      1) Attenuation.
      2) Near end cross talk.
      3) Far end cross talk.
      4) Total cable length (not to exceed 90 meters for Category 6 cabling).
   f. Repair or replace any defective cables, terminations, or splices.
3. Test results to be provided to the Engineer at the completion of the project.

END OF SECTION – 27 10 00
PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.

B. All bids shall be based on the equipment as specified herein. The catalog numbers and model designations are that of the Bogen Nyquist E7000 Series Educational System. The specifying Engineer must approve any alternative system.

C. Contractors who wish to submit alternative equipment shall provide the specifying authority with the appropriate documentation at least 15 business days prior to bid opening. The submitted documentation must provide a feature by feature comparison identifying how the proposed equipment meets the operation and functionality of the system described in this specification. Prior to bid date, the contractor shall provide adequate and complete submittal information, which shall include but not be limited to specification sheets, working drawings, shop drawings, and system demonstration. The alternative supplier-contractor must also provide a list to include six installations identical to the proposed system.

D. The contractor shall provide the FCC registration number of the proposed system, where applicable.

E. Final approval of the alternative system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the alternative system at the contractor’s expense.

F. The contractor for this work shall have read all the bidding requirements, the contract proposal forms, and shall be held to the execution of this work. The contractor shall be bound by all the conditions and requirements therein.

G. The contractor shall be responsible for providing a complete functional system, including all necessary components whether included in this specification or not.

H. In preparing the bid, the contractor should consider that no claim will be made against the owner for any costs incurred by the contractor for any equipment demonstrations requested by the owner.

1.2 SCOPE OF WORK

A. The contractor shall furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating VoIP school communications system including but not limited to:

1. Nyquist NQ-E7030 Analog Station Bridge (ASB)
   a. 24 station interface supporting analog speakers and call switches
   b. Built-in 2x120W power amplifiers
   c. Two speech links
   d. Category wiring
   e. 25/70-volt speaker(s), ceiling-mounted, wall-mounted, and paging horns
1) Ceiling Mounted Speakers: CSD2X2U Drop-In Ceiling Speaker
2) Ceiling Mounted Speakers: S810T725PG8U Ceiling Speaker
3) Wall Baffle Speakers: MB8TSQ/SL Metal Box Speaker

f. Analog/Mechanical Call Switches capable of placing Normal, Urgent, or Emergency priority calls
   1) CA-15C rocker style momentary call button
   2) CA-21B rocker style momentary call button with a push on position for privacy

g. CAN Bus 2.0 interface designed for future support of Nyquist Digital Call Switch (DCS) NQ-E7020 that can initiate Normal, Urgent, or Emergency priority calls, all with options for Privacy Mode

2. Nyquist NQ-P0100 Matrix Mixer Pre-Amplifier (MMPA)
   a. Four Mic/Line inputs that are user-configurable
   b. Line-Level/Monitor output
   c. Digital AES/EBU (AES3) input

3. Nyquist NQ-E7010 Input/Output (I/O) Controller
   a. Eight inputs to monitor third-party device events
   b. Eight outputs to initiate third-party device actions
   c. Power over Ethernet (PoE) Class-1 (IEEE 802.3af compliant)

4. Nyquist NQ-S1810WT Classroom VoP Wall Baffle Speakers(s)
   a. Adjustable volume (100 steps minimum) via web browser
   b. Built-in 10W amplifier
   c. MEMS digital microphone for full duplex talkback
   d. PoE Class-3 (IEEE 802.3af compliant)
   e. Connection to optional Nyquist DCS NQ-E7020, which can place Normal, Urgent, or Emergency priority calls and can provide station status and the ability for the user to enable and disable Privacy Mode

5. Built-in Master Clock with the following minimum features:
   a. Unlimited Events
   b. Unlimited Concurrent Schedules
   c. Unlimited Holidays

6. Nyquist E7000 Series Educational System Software shall be installed on a dealer or a customer-supplied server with the following minimum specifications:
   a. Web Server for full system configuration and operation
   b. Nyquist web-based Administrative User Interface (Admin Web UI) for programming and day-to-day system operation, including but not limited to:
      1) Station intercom two-way calling
      2) Zone Paging with software-adjustable volume per zone
      3) Emergency Paging
      4) Playing Emergency Tones
5) Playing Tones
6) Playing Announcement Files
7) Managing Bell Schedules
8) Weekly Bell Schedule Review at-a-glance
9) Audio Distribution
10) System muting

7. Teacher’s Dashboard web-based UI for teachers, including but not limited to:
   a. Directory
   b. Dial Pad
   c. Voicemail
   d. Call Forwarding
   e. Single-click or touch Normal or Emergency calling
   f. Single-click or touch 911 calling

8. VoIP Admin Phone, PoE, 7" 800 x 480-pixel color touch screen with backlight

9. VoIP Staff Station, PoE, 132 x 64-pixel graphical LCD with backlight

10. Owner Telephone System Connectivity
    a. System shall be capable of connecting to the Public Switched Telephone Network (PSTN), analog Public Branch Exchange (PBX), or digital PBX/IP-PBX by connecting to an unlimited number of SIP trunks, analog FXO/FXS lines, or CO Trunks.
    b. Telephone service with public utilities will be arranged by the owner in conjunction with the equipment supplier. Equipment supplier shall generate a one-page document that will provide the owner with the number of outside lines.

1.3 SUBMITTALS
   A. Spec Sheets on all items including cable types
   B. Outline drawing of system control cabinet showing relative position of all major components
   C. Shop drawings, detailing integrated electronic communications network system including, but not limited to, the following:
      1. Station wiring arrangement
      2. Equipment cabinet detail drawing
   D. Wiring diagrams showing typical connections for all equipment
   E. Numbered Certificate of Completion for installation, programming, and service training, which identifies the installing technician(s) as having successfully completed the Nyquist E7000 technical training course provided by the Bogen Communications, Inc.

1.4 QUALITY ASSURANCE
   A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
   B. The contractor shall be an established communications and electronics contractor that maintains a locally run and operated business and has done so for at least 10 years. The
contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

C. The contractor shall show satisfactory evidence, upon request, that he or she maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain at his or her facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

1.5 SINGLE SOURCE RESPONSIBILITY
A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and a minimum of 30 years of experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service training classes. A certificate of this training shall be provided with the contractor's submittal.

1.6 SAFETY / COMPLIANCE TESTING
A. The communications system and its components shall, where applicable, bear the label of a Nationally Recognized Testing Laboratory (NRTL), such as Environmental Technology Laboratory (ETL), and shall be listed by their re-examination service. All work must be completed in strict accordance with all applicable electrical codes, under direction of a qualified and factory-approved contractor, and to the approval of the owner.

1.7 IN-SERVICE TRAINING
A. The contractor shall provide a minimum of eight hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. User Guides shall be provided at the time of this training.

1.8 WIRING
A. System wiring and equipment installation shall be in accordance with generally-accepted engineering best practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall be tested to be free from grounds and shorts.

B. All system wiring shall be labeled at both ends of the cable. All labeling shall be based on the room numbers as indicated in the architectural graphics package.

C. Wiring shall be done per manufacturer's recommendation (Cat 5 or West Penn #357) depending on speaker type. All terminal connections are to be on barrier strips.

1.9 PROTECTION
A. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.

B. The contractor shall note on their system drawings, the type and location of these protection devices and all wiring information. Such devices are not to be installed above the ceiling.

1.10 SERVICE AND MAINTENANCE
A. The contractor shall provide a five-year equipment hardware warranty of the installed system against defects in material and workmanship. All materials shall be provided at no
expense to the owner during normal working hours. The warranty period shall begin on 1st of the month following the date of shipment.

B. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of this system after the initial hardware and software warranty periods.

C. System shall include software maintenance that includes bug fixes and new feature releases for a period of six years.

D. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

PART 2 - SYSTEM SPECIFICATION

2.1 MANUFACTURERS

A. Manufacturers, subject to compliance with requirements specifications, provide the following system:

B. Bogen Nyquist E7000 Series Educational System manufactured by Bogen Communications, Inc.

C. The following manufacturers are also approved for bidding, provided the system provided is equivalent to the system specified under this specification. The specifying authority must approve any alternative system 5 days prior to bid day.
   1. Carehawk by Dukane.
   2. Rauland.

D. The intent is to establish a standard of quality, function, and features. It is the responsibility of the contractor to ensure that the proposed product meets or exceeds every standard set forth in these specifications.

E. The functions and features specified are vital to the operation of this facility; therefore, inclusion in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.

2.2 EQUIPMENT

A. Nyquist NQ-E7030 Analog Station Bridge
   1. 24 station support
   2. 120W of total available power; max. 40W per any individual port
   3. 25 Volt Speakers(s)
   4. Analog Call Switch(s)
   5. Software programmable configuration and operation
   6. Rack mounted, wall mounted, or shelf mounted
   7. CAN Bus 2.0 interface for future support for NQ-E7020 DCS

B. Nyquist NQ-P0100 Matrix Mixer Pre-amplifier
   1. No less than four Line/Microphone Level Inputs used for:
      a. CD Player
      b. AM/FM Tuner
      c. Push-to-Talk Paging Microphone
      d. MP3 Player
e. Digital AES/EBU (AES3) input
2. Line Level output to drive external amplifier
3. Software programmable configuration and operation
   a. Push-to-Talk Channel
   b. Push-to-Talk Type
   c. Push-to-Talk Zone
   d. Mixer Channels
4. Mixer Channels Wall or shelf mounted

C. Nyquist NQ-E7010 Input/Output Controller
1. Eight Dry Contact Inputs
2. Eight Open Collector Outputs
3. Software programmable configuration and operation including:
   a. Contact Type
   b. Extension
   c. Name
   d. Close Interval
   e. Actions including:
      1) Audio
      2) Alarm
      3) Announcement
      4) Disable-Audio
      5) Other
      6) Tone
      7) Enable-Audio
   f. Action ID
   g. Zones
   h. Close Extension
   i. Dashboard Type
   j. Dashboard Title
   k. Dashboard Scope
   l. Dashboard Text
   m. Dashboard Style
   n. Email
4. Wall or shelf mounted

D. Nyquist Station Equipment

1. NQ-T1100 VoIP Admin Phone – Color Touch Display (aka Admin Station)
2. NQ-T1000 VoIP Staff Phone – LCD Display (aka Staff Station)
3. CSD2X2U Drop-In Ceiling Speaker
4. CA15C Analog Call Switch

2.3 COMPONENTS AND DESCRIPTIONS

The Nyquist E7000 Series Educational System is a software-based VoIP paging and intercom system.

The Nyquist E7000 Series Educational System must be capable of supporting existing Bogen Multicom 2000 and Bogen Quantum Multicom IP wiring, 25 volt speakers and analog call-switches, and equivalent competitive systems utilizing the existing architectural numbering scheme. The VoIP capabilities of the Nyquist system will enable the support of the features across
the various Nyquist appliances within the facility. The following sections define how the system handles each of the features in the system. Systems that do not allow the reuse of existing wiring or numbering scheme shall not be deemed acceptable. Systems that do not allow appliances to be seamlessly integrated via the LAN are not considered equal.

A. Nyquist E7000 Server Software

1. The Nyquist E7000 server software shall be installed on a dedicated dealer or customer supplied server. An unlimited number of facilities can be networked into a Nyquist-based District.
   a. Minimum Nyquist Server Requirements
      1) Debian Linux OS (AMD 64-bit version) release 8.4.x – 8.8.0
      2) Quad-core Intel-based processor running at 3.0 GHz or higher
      3) 8 GB RAM
      4) One 500 GB RAID array
      5) NIC 10/100/1000 MB Ethernet port
      6) One or more PCI/PCI Express (PCIe) slots if telephony network connectivity other than, or in addition to, SIP trunking
      7) One or more PCI/PCIe type third-party telephony interface cards (for example, FXO, FXS, etc.) if telephony network connectivity other than, or in addition to, SIP trunking

2. Audio shall be transmitted between the server and the Nyquist appliances using the customer supplied LAN/WAN using both G.722 and Opus 48k audio encoding and streaming technology to deliver High Definition audio quality. Systems that do not use G.722 and Opus for audio encoding and streaming shall not be deemed equivalent.

3. The Nyquist server software and Nyquist appliances software shall be upgradeable via the Nyquist Web UI.

4. It shall be possible for a Nyquist facility to make “station-to-station” calls and “remote facility” All-Call pages to a single facility or to all Nyquist facilities in a district via the Nyquist Web UI or an Admin Station. Systems that require remote viewing software or other application software to be installed/loaded on to additional servers or PCs to make station-to-station calls and remote facility All-Call or district paging shall not be considered equivalent.

5. The Nyquist server software is designed to handle all facility and district-wide communications, including but not limited to, inter-facility intercom calling and paging, district-wide Emergency All-Call and local facility point-to-point calls. Via the Nyquist Web UI, every facility shall be configured with the IP addresses of all the other remote facilities within the district.

6. Nyquist can support an unlimited number of facilities; however, the maximum number of simultaneous remote facility intercom calls supported is based on the actual performance of the WAN and the Nyquist Server CPU load.

7. The voice quality of the facility calls may vary based on the WAN conditions. The maximum network bandwidth that All-Call and Zone Paging uses is 64 kbps (Multicast G.722), and intercom calls use 128 kbps (unicast, G.722).

8. The system shall facilitate the repetitive playing of Normal or Emergency audio tones or announcements directed to a Paging Zone until stopped by the Nyquist user via the Web UI, an Admin Station, or a dry contact closure connected to the Nyquist I/O Controller NQ-E7010.

9. A built-in Master Clock shall be included to automatically control class change bells or other time-based signals. The Master Clock shall have an unlimited
number of Events that may be programmed into any of the unlimited number of Schedules, and unlimited number of Holidays. The schedules shall be nameable for easy selection when assigning schedules to days or overriding a schedule.

10. Network Time Synchronization. The system shall be capable of periodically updating/synchronizing the processor’s time with a Network Time Server running Network Time Protocol (NTP) via the school’s LAN network. Systems that do not provide Network Time Synchronization will not be deemed equivalent. The Nyquist server can be the NTP server for other devices on the LAN such as IP clocks and other IP devices.

B. Nyquist Server Application
1. The Nyquist software is installed onto the server, and upon boot-up, users can log in to the Nyquist server application via a web browser that supports WebRTC. Systems that require Com Port redirect software, client PC application, software or serial-to-Ethernet adapters for user access are not deemed equal. Communications between the server and the Web UI(s) shall be via secure Hyper Text Transfer Protocol (HTTPS) connections (i.e., https://).

2. The Nyquist Web UI shall be configured with four different default user access levels, based on four unique user roles. Systems that do not provide unlimited access levels and unlimited user roles are not considered equal.
   a. The four default roles shall be: admin, optech, operator, and user. These roles provide a starting point/example for administrators to create additional roles.

3. Only a user assigned the admin role shall be able to provide access to users, giving them the ability to create, delete, edit, and view system parameters.

4. Only an Administrator shall have the ability to adjust roles and Class of Service (CoS) of users. The roles determine if users can view the definable data objects that can include configuration, alarms, and performance data and if users can perform certain operations based on the user’s role and station’s CoS. All changes to roles and CoS are effective immediately, without the need to restart the browser or reboot the server.

5. The Nyquist Web UI Dashboard shall provide full administrative capabilities to manage/operate the following system features:
   a. Calling/Paging – User can initiate a call by accessing the directory or by dial pad and can receive calls, make Zone Page and All-Call Page, make a Prepending Page, Emergency All-Call paging.
   b. Call Forwarding
   c. District Calling/Paging – Used for District Facility Page, District All-Call, and District Emergency All-Call.
   d. Tones/Announcements – Used to play Tones, Announcements, and Alarms.
   e. View This Week’s Schedule – Used to show the current interactive Bell Schedule.
   f. Audio Distribution – Used for entire facility or Audio Zones
   g. Enable or Disable Audio – Used to place the Nyquist system into Page Exclusion mode (i.e., “mute” the system) when a contact closure is supplied from the fire alarm panel. Systems that do not provide this capability are deemed not equal.
   h. Systems that require application software to be installed on a PC to manage the above features shall not be considered equivalent.
6. To facilitate installation and configuration of the system, additional Web UI menus are required. The menus shall only be visible to users with the correct roles and CoS. The navigation menus found on the Web UI shall be as follows:
   a. System Parameters – Allow installers to adjust core system parameters.
   b. Zones – Allow installers to create and modify Paging, Time, and Audio Zones.
   c. Schedules – Allow installers and administrators to create bell schedules for the facility, predefine alternative schedules to run, prevent the bells from ringing on a holiday, and schedule an announcement to play. The system shall allow an unlimited number of schedules to operate simultaneously within a facility.
   d. Admin Groups – Allow the installer to create, modify, and delete software groupings of admin phones that can ring when a station calls in with a call switch.
   e. CoS Configuration – Allow the installer to create, modify, and delete CoS groups that control station access to the following features: Call-in Level, Zone Paging, All-Call Paging, Emergency All-Call, Inter-Facility Call/Page, Audio Distribution, Remote Pickup, Join Conversation, Call Forwarding, Walking Class of Service, External Call Routing, Call Transfer/3-way Calling, Manually Activate Tone Signals, Call Any Station, Manage Recording, Monitor Calls, Monitor Locations, Conference Admin, Conference User, Voicemail, Record Calls, Activate Alarm Signals, Disable Audio, Enable Audio, Allow Callee Auto-answer, District Paging, and Inter-Facility Features.
   f. Stations – Allow the installer to set up, modify, and delete stations; set up Page Exclusion; view Station Status; and add New Stations.
   g. Bridge Devices – Allow the installer to configure the Nyquist ASBs.
   h. Audio – Allow the installer to upload and manage Announcements, Playlists, Songs, and Tones. The system must support the uploading of both MP3 and WAV files and make Audio file management simple for users. Systems that limit the size of Audio files shall not be considered equal.
   i. Users – Allow the installer to manage users by giving them the proper roles and assign extensions if needed.
   j. Roles – Allow the installer to grant users rights to Create, Delete, Edit, Restart Server, Sort Menu, Systems Update, Manage, Import/Export, Restore, Settings, or View.
   k. Facilities – Allow the installer to set up the district wide facilities for remote paging and calling.
   l. Outside Lines – Allow the installer to set up FXS and FXO ports for inbound and outbound system calling.
   m. SIP Trunks – Allow the installer to set up SIP trunks into the facility for inbound or outbound calling.
   n. Call Details – Allow the installer to review the historical system activities that can be used for incident investigation or system troubleshooting.
   o. System Backup/Restore – Allow the installer to perform system backups or restores and allow the backups to be schedule to run automatically.
   p. System Logs – Allow the installer to view and export Server, Nyquist-Intercom, and Web Server logs that can be used for troubleshooting and technical assistance.
q. Paging Exclusions – Allow the installer to view and edit stations that are excluded from paging.

r. Firmware – Update firmware for Nyquist speakers and appliances.

s. Help – Provide information about the system, online help topics, and System Administrator Manual.

t. Systems that do not provide these menus as a minimum shall not be considered equal.

C. Nyquist NQ-E7030 Analog Station Bridge

1. The Nyquist NQ-E7030 ASB allows facilities with existing Multicom or Quantum or compatible intercom systems to upgrade to Nyquist. Each ASB supports up to 24 speakers and call switches with 120 Watts of embedded 25 Volt power. The ASB is designed to drive any combination of 25 Volt speakers and horns. Features Include:
   a. 10/100 Ethernet
   b. 24 station interface - Supports connections to as many as 24 individual 25 Volt speakers with one 25 Volt speaker connection per interface
   c. 24 dry contact closure-type analog Call Switch connections
   d. Half-duplex talkback using speaker as pickup
   e. CAN Bus 2.0 Interface for future NQ-E7020 DCS support and other accessory devices
   f. 120W of available power across all 24 channels; maximum 40W per channel
   g. 2 x RGB full spectrum LED status indicators
   h. USB 2.0 host port, type A connector (future use)
   i. Universal mains supply (100VAC – 240VAC)

2. The Nyquist NQ-E7030 ASB shall be rack, wall, or shelf mountable and shall include the required mounting bracket hardware.

D. Nyquist NQ-P0100 Matrix Mixer Pre-Amplifier (MMPA)

1. The Nyquist NQ-P0100 MMPA is designed to bring external audio into the Nyquist system. The MMPA interfaces with a local sound system by accepting one or more local audio sources, mixing them, and outputting them to either, a) the network for Audio Distribution, or b) the MMPA’s line level output that can then be inserted into an external amplifier to drive local sound system in gyms, cafeterias, auditoriums, etc. The MMPA supports the following:
   a. Four software selectable MIC or Line Input channels via three XLR connectors and four sets of screw-terminals. Any single input channel shall be capable of being configured to support a Push-to-Talk microphone (for example, Bogen DDU-250). Channel-1 can be configured as a digital AES/EBU (AES3) input. Line/Monitor output – The MMPA becomes a station on the Nyquist system, allowing users to call it directly or to include it in any of the Page, Time, or Audio Zones.
   b. The MMPA shall support the following features: Line-Level output to drive input on a local amplifier; One USB 2.0 host port (Type-A connector) for future use; 2 x RGB full spectrum LED status indicators.
   c. The MMPA is powered by Universal mains supply (100VAC – 240VAC).
   d. The MMPA shall be wall or shelf mountable and shall include the required mounting bracket hardware.
2. The dealer shall supply a minimum of one Nyquist MMPA that allows for up to four user-configurable audio inputs. The MMPA shall support Line, MIC, and digital AES/EBU (AES3) input sources. The system shall support an unlimited number of MMPAs.

E. Nyquist NQ-E7010 Input/Output Controller
1. The Nyquist NQ-E7010 I/O Controller is designed to accept contact closure inputs and activate open-collector outputs to drive relay coils.
   a. PoE Class-1; IEEE 802.3af compliant with Optional 48VDC 15W power supply
   b. Eight Dry Contact Closure Inputs that can be used with Fire Alarm Override Relays, external event triggers (for example, Lockdown Buttons, etc.)
   c. Eight Relay Driver Outputs (Open-Collector) for use with Clock Correction (Sync Pulse), response to contact closure inputs, etc.
   d. USB 2.0 host port, Type-A connector (future use)
   e. 2 x RGB full spectrum LED status indicators
2. The Nyquist NQ-E7010 I/O Controller shall support wall or shelf-mounting options and shall include the required mounting bracket hardware.
3. The Nyquist NQ-E7010 I/O Controller shall be designed for wall or shelf mounting.

F. Nyquist VoIP Admin Phone – Color Touch Display (Admin Station)
1. The Nyquist Admin Station shall have the following features:
   a. 7” 800 x 480-pixel color display with backlight
   b. Touch screen display for one touch operation
   c. Full-duplex hands-free speakerphone with AEC
   d. Call hold, mute
   e. Redial, call return, auto answer
   f. PoE (802.3af) Class-3 support
   g. Headset with EHS support
   h. Dual Gigabit Ethernet ports
   i. Desk Mountable
   j. Optional Wall mount capable
2. The Nyquist Admin Station display panel shall show the time of day and day of week, the current bell schedule(s), and the station numbers and call-in priority of staff stations that are calling in. Depending upon the system programming, an Admin Station shall display menus to activate Zone Paging, All-Call Paging, Emergency All-Call Paging, District All-Call paging, alarm signals, and external functions.
3. The Admin Station shall be capable of calling either the loudspeaker or Staff Station at each classroom location.
   a. The Admin Station shall display the classroom number of any station that calls 911. This allows front-office administrators to direct emergency personnel to the correct physical location in the building when they arrive. If a system is not connected to outside phone lines, then 911 calls can be routed to a designated station within the facility. The system shall automatically record all 911 calls made from any station. The 911 call recording shall begin as soon as 911 is dialed and continue until the call is terminated. Recorded calls shall be maintained on the system for later playback review and/or retrieval by authorized personnel and/or
Nyquist NQ-T1000 Staff VoIP Phone – LCD Display (Staff Station)

1. Nyquist Staff Station shall have the following features:
   a. 132 x 64-pixel graphical LCD with backlight
   b. Two-port 10/100M Ethernet Switch
   c. Full-duplex hands-free speakerphone with AEC
   d. Call hold, mute
   e. Redial, call return, auto answer
   f. PoE (802.3af) Class-3 support
   g. Dual-color (red or green) illuminated LEDs for line status information
   h. Two 10/100M Ethernet ports
   i. Wall or desk mountable

2. The classroom Staff Station shall be capable of the following features depending on how the station CoS is configured:
   a. Emergency intercom call – Staff Stations shall be capable of making an Emergency intercom call, which is then routed to the assigned Admin Station. This requires the display of the architectural number and call in level on the Admin Station. Systems that do not provide this feature are not equivalent.
   b. Speed dial
   c. Toggle audio distribution on and off
   d. Call Forward activation and deactivation for All-Calls/Busy/No Answer/Busy or No Answer
   e. Conference Calling
   f. Transfer Call
   g. Dial Administrative station– Staff Stations can allow the user to dial the station number to call to the Admin phone or its associated speaker. The call shall be routed to the Admin Station showing the architectural number that is calling.
   h. Emergency All-Call – An emergency page shall be broadcasted to all the stations in the facility.
   i. Place Outside Call
   j. Remote Answer
   k. Single-Zone/All-Station Page
   l. Call Waiting Tone for Outside Calls – It shall be possible to feed the call waiting tone to the Administrative Phone during a conversation.
   m. Transfer call from VoIP speaker in classroom down to an associated Staff Station
   n. Transfer call from analog speaker in classroom down to an associated Staff Station
   o. Transfer call from VoIP Staff Station in classroom up to an associated VoIP speaker
   p. Transfer call from Staff Station in classroom up to an associated analog speaker

H. Nyquist NQ-S1810CT VoIP Ceiling Speaker with Talkback and NQ-S1810WT VoIP Wall Baffle Speaker with Talkback
1. The VoIP speakers shall not require traditional intercom wiring or transformer taps to manually set or adjust volume. Simply connecting them via Cat 5 to a PoE Switch or PoE Injector on the system’s network should allow them to be ready to program into the system. Volume is controlled via the Nyquist Web UI. All Nyquist audio appliances shall use a wideband Opus codec for Audio Distribution. Use of the Opus codec, along with G.722, allows for High Definition audio. Nyquist VoIP speakers shall be equipped with a digital MEMS microphone to achieve superior talkback audio. VoIP Speakers that utilize the speaker as the microphone shall not be considered equal.

2. The NQ-S1810WT VoIP Wall Baffle Speaker with Talkback design facilitates mounting the speaker up to four different ways:
   a. 2x2 Wall Mount
   b. Box Mount
   c. Corner Mount
   d. Tilted Mount

3. The VoIP Speakers provide CAN Bus 2.0 Interface support for the NQ-E7020 DCS.

4. The VoIP Speakers shall be PoE IEEE 802.3af compliant. VoIP speakers may be placed up to 100 meters (328 Feet) from a PoE switch or PoE Injector.

5. Software provides adjustable audio output level.

6. DHCP with Option 66 is supported for easy network deployment.

7. The VoIP Speakers provide VLAN support.

8. The VoIP Speakers are pre-assembled for faster installation.

9. Each VoIP Speaker includes a 10 Watt integrated power amplifier.

10. Each VoIP Speaker has a digital MEMS microphone to support talkback.

I. Nyquist NQ-E7020 Digital Call Switch

1. The Nyquist DCS has been exclusively designed for use with Nyquist appliances equipped with a CAN Bus 2.0 Interface. The CAN Bus 2.0 interface provides power and signal, and multiple DCSs can connect to each CAN Bus 2.0 interface. The DCS fits into a Single Gang/ Low Voltage installation using standard ‘decora-plate’ covers (supplied).

2. The DCS is a capacitive touch button design, so it doesn’t have any moving parts to wear out. The behavior of this switch is software definable. Systems that require membrane or mechanical rocker style call switches that can wear out over time shall not be acceptable.

3. Normal call initiation involves touching the DCS one time. When a user touches the button on the DCS once, one of the three LED segments will light up green, a normal call will be placed, and the light will start blinking green. This is the indication that the Normal call has been placed to the VoIP Admin Phone or to a group of VoIP Admin Phones and that the phone or phones are ringing.

4. Urgent call initiation involves touching the DCS one time. When a user touches the button on the DCS once, one of the three LED segments will light up yellow, an Urgent call will be placed, and the light will start blinking yellow. This is the indication that the Urgent call has been placed to the VoIP Admin Phone or to a group of VoIP Admin Phones.

5. Emergency call initiation involves touching the DCS one or three times depending on station programming. When a user touches the button on the DCS one or three times within three seconds, all three LED segments will light up red, an Emergency call will be placed, and the light will start blinking red. This is the
indication that the Emergency call has been placed to the VoIP Admin Phone or to a group of VoIP Admin Phones.

6. Single Press Emergency Call, if programmed, involves touching the DCS one time. When a user touches the button once, all three LED segments will light up red on the DCS, an Emergency call will be placed, and the light will start blinking red. This is the indication that the Emergency call has been placed to the VoIP Admin Phone or to a group of VoIP Admin Phones.

7. Normal and Urgent calls can easily be upgraded to an Emergency call after the DCS is flashing by touching the button on the DCS one time. The Normal or Urgent call will be canceled and an Emergency call will be placed.

8. Privacy Mode – Pressing and holding the button on the DCS for four seconds will place the speaker into Privacy Mode. As the user continually touches the DCS button, all LED segments will turn purple; when all three LED segments are lit purple, the speaker is in Privacy Mode. If a call comes into the classroom when the station is in Privacy Mode, the microphone will be disabled; the user in the classroom can touch the DCS once and it will allow talkback. Once the call ends, the classroom will need to manually return the speaker into Privacy Mode, if desired. The user can disable Privacy Mode without placing a call by pressing and holding the button on the DCS for four seconds. As the user continually touches the DCS, all LED segments will turn blue. When all three LED segments are lit blue, the speaker is no longer in Privacy Mode. Systems that require mechanical or membrane switches to achieve Privacy Mode shall not be considered equal.

9. The colors specified above are created by three RGB full spectrum LED segments to provide installers and users with visual status and feedback when installing and using the DCS. When the DCS is being installed and the power is connected before the signal, the LED will light red. It will also light red if the speaker in the classroom stops communicating with the Nyquist Server, indicating a problem with the station.

10. In addition to providing visual call status indications, a call confirmation audio file shall be played on the associated loudspeaker when a call is placed via a DCS. The three call-in levels shall have distinct audio confirmation messages:
   a. Call Placed
   b. Urgent Call Placed
   c. Emergency Call Placed

11. Emergency Link Transfer – If an Emergency call is unanswered by the VoIP Admin Phone and the Emergency Link Transfer is active, the Emergency call will be forwarded to the loudspeaker associated with the Emergency Link Station. Any station equipped with a loudspeaker can be programmed as the Emergency Link Station. Systems that do not provide Emergency Link Transfer shall not be considered equal.

J. Additional Loudspeakers for use with the Nyquist ASB

1. Classroom Speakers shall be Bogen:
   a. Ceiling Mounted Speakers: S810T725PG8U Ceiling Speaker
   b. Wall Baffle Speakers: MB8TSQ/SL Metal Box Speaker
2. Hallway Speakers shall be Bogen:
   a. Ceiling Mounted Speakers: CSD2X2U Drop-In Ceiling Speaker
   b. Ceiling Mounted Speakers: S810T725PG8U Ceiling Speaker
   c. Wall Baffle Speakers: MB8TSQ/SL Metal Box Speaker
3. Outdoor/Gym/Locker Room Speakers shall be Bogen:
   a. FMH15T mounted in BBSM6 surface-mounted vandal-resistant enclosure/BBFM6 flush-mounted vandal-resistant enclosure with FMHAR8 adapter ring and SGHD8 heavy duty grille
   b. KFLDS30T Wide Dispersion Re-entrant Horn Loudspeakers
4. Common Area Speakers shall be Bogen:
   a. OCS1 Orbit Ceiling Speakers or as indicated on the Drawings.

2.4 SYSTEM CAPABILITIES

A. The communication system shall be a Bogen Nyquist E7000 Series Educational System and shall provide a comprehensive communications network between administrative areas and staff locations throughout the facility.

The system shall provide no less than the following features and functions:

1. Software-based, state-of-the-art, Voice over IP (VoIP) paging and intercom solution.
2. The system shall provide a Web User Interface (Web UI) shall allow users to configure and control the system, in accordance with their assigned User Role, from any Web browser enabled PC, Mac, Android or iOS tablet or mobile device.
3. Amplified-voice communication with analog loudspeakers shall use a shielded audio pair when connected to an ASB.
4. The system shall support any combination of the following VoIP phone station types: NQ-T1100 Administrative VoIP Phone – Color Touch Display (Admin Station) or NQ-T1000 Staff VoIP Phone – LCD Display (Staff Station).
   a. All VoIP phone station types shall utilize the same type of field wiring.
   b. There shall be no limit to the number of Admin Stations that can be connected to a facility. Systems that require different head-end equipment to make Admin Stations function, or systems that limit the number of Admin or Staff Stations shall not be deemed acceptable.
5. Future station alterations shall only require the Station Type to be changed in system programming. Alterations shall not require field wiring or system head-end alterations, unless an analog station device is being replaced by a VoIP station device or vice-versa.
6. The system shall be a global non-blocking system. The system shall be capable of unlimited amplified intercom paths per facility. Two amplified intercom paths shall be provided with each ASB for its complement of 24 stations. All hardware, etc., required to achieve the necessary number of amplified-voice intercom channels for this system shall be included in this submittal. ASB amplified-voice intercom channels shall provide voice-activated switching. Systems requiring the use of a push-to-talk switch on administrative telephones shall not be acceptable. There shall be an automatic level control for return speech during amplified-voice communications. The intercom amplifier shall also provide control over the voice switching sensitivity and delay times of the VOX circuitry on the ASB.
7. The system shall provide 911 Dial-Through via outside FXO/FXS lines or SIP trunks to ensure that one or more lines are always available for 911 calls. The 911 Dial-Through is available to any properly configured station (via CoS). When a station dials 911, the 911 call is processed as follows:
a. Call routes to an Emergency Group where the call can be answered.
b. The 911 CO lines can be pre-configured and reserved. If the 911 reserved lines are busy, the normal CO lines will be connected to route the 911 calls. If all the normal CO lines are busy, then one of the ongoing calls shall be disconnected and the 911 call shall be placed.
c. When 911 is dialed from any station, its designated Admin Station or Admin Group will receive a message that the station has dialed 911.
d. The system shall automatically record all 911 calls made from any station. The 911 call recording shall begin as soon as 911 is dialed and shall continue until the call is terminated. Recorded calls shall be maintained on the system for later playback review and/or retrieval by authorized personnel and/or authorities.

8. It is of highest importance that Emergency calls from stations receive prompt attention. Therefore, it is important that there be an alternative destination in case the Emergency call does not get answered at the primary location. Details are as follows:

a. Staff-generated Emergency calls shall be treated as the second highest system priority. Therefore, all Emergency calls shall annunciate at the top of the call queue of their respective Admin Station or Admin Group. Should that Emergency call go unanswered for 15 seconds, the call shall be re-routed to an alternative speaker station. Then, a tone will prompt the caller to make a verbal call for help and annunciates to the Emergency link station “Emergency.” During the transfer, the original administrative telephone shall continue to ring the distinctive Emergency Ring. Should the Emergency Transfer-to-Station have an associated Admin Station, it will also ring for the Emergency call.
b. The Emergency Transfer-to-Station shall be software configurable.
c. Systems failing to transfer unanswered Emergency calls or failing to immediately connect to the designated Admin Station shall not be deemed as equal.

9. There shall be a Facility Wide Emergency All-Call feature. The Emergency All-Call shall be accessed from designated Admin Stations or the Nyquist Dashboard or by the activation of an external contact closure that shall give a microphone input Emergency status. The Emergency All-Call function shall have the highest system priority and shall override all other loudspeaker-related functions including Time Tones, Normal All-Call or Zone Pages, or Audio Distribution.

a. Considering that Emergency calls are to be treated with the highest level of concern, systems that do not regard Emergency All-Call with the highest priority shall not be deemed as equal.
b. Upon touching the Directory icon, a menu shall appear on the Admin Station display prompting the user to select the desired menu.
c. The Emergency All-Call shall capture the highest-level system priority and shall be transmitted over all speakers in the facility. It shall also be capable of activating an external control output, which can be used to activate external relays to automatically override volume controls, local sound systems, or strobe circuits.
d. Systems without Emergency All-Call or systems with All-Call that cannot be activated by external means or that do not capture complete system priority or activate an external relay, shall not be acceptable.
10. There shall be unlimited Alarm Tones (four by default). Each may be accessed by
dialing *91 and the two-digit tone number from any Admin Station, SIP Trunk, or
FXO/FXS system interface. These Alarm Tones are separate from the Time
Tones. Users shall be able to add an unlimited number of Alarm Tones to the
system by uploading MP3 or WAV files. Systems that do not Systems that do not
allow the user to upload MP3 and WAV files to customize the Alarm Tones or
need to use external alarm/tone generators or special software or have less than
four Emergency Alarm Tones shall not be acceptable.

11. Upon touching the Directory icon on an Admin Station, a menu shall appear on
the display prompting the user to select from the sub-menus. The Alarms sub-
menu is the first available. This precludes the user from having to memorize
complicated key sequences to access Alarm Tones.

12. There shall be unlimited I/O Controller relay driver outputs accessible and
controllable by properly authorized users via an Administrative Web UI. These
outputs remain set until accessed and reset. Users shall have the ability to review
the status of each relay driver output. Users shall be prompted through fields via a
plain English menu, precluding users from having to remember any dialing
sequences to control this feature. The system shall support an unlimited number of
I/O Controllers, and each I/O Controller shall be able to interact with any and all
other I/O Controllers on the system (i.e., an input on one I/O Controller can
trigger an output on one or more different I/O Controllers). Systems that require
the user to remember complicated dialing schemes or prompt the user via cryptic
commands shall not be acceptable.

a. The I/O Controller can create a contact closure when the following
operations are performed in the system:

1) 911 call placed
2) Audio Distributed
3) Alarm is played
4) Announcement is played
5) All-Call preformed
6) District All-Call performed
7) District-Emergency-All-Call
8) Emergency-Call
9) Emergency-All-Call
10) Audio-Disabled
11) Page

13. The system shall provide software controlled and programmable control outputs
for external relay activation for use with strobe lights, magnetic locks, card access
systems, motion detectors, cameras, or any low-voltage, dry contact creating
device. Systems using dedicated security stations for control of external functions
shall not be acceptable.

14. The system shall be capable of interfacing to PSTN/PBX/iPBX via both
FXO/FXS line and SIP trunk connectivity.

15. The system shall be capable of providing each facility (i.e., (i.e., Nyquist location)
an unlimited number of incoming FXO/FXS or SIP trunk lines that can be
designated by the user to ring the designated Day Admin or Night Admin. Where
an Admin Station is designated to receive outside line calls, the incoming call’s
Caller ID information shall appear on the display. The system shall also provide
the ability to make outside line calls from Admin Stations. This ability shall be
programmable for each Admin Station and there shall be an unlimited number of CoSs available to assign to any station.

16. The system shall be capable of supporting DID, DISA, and Security DISA functions.
   a. The system shall provide a password-protected Security DISA feature that shall only be accessible from authorized Police, Fire, Emergency personnel, or an off-premise security office that monitors the facility’s security system. The Security DISA feature shall function as follows: Upon dialing the Security DISA phone number, the caller will receive a dial tone from the system, after which he or she must enter the assigned Security DISA passcode on the dial pad. Upon confirmation, the system will present the dial tone again and will allow the authorized personnel to dial any station/classroom on the system and monitor the activity without any pre-announce tone or privacy beep. This will allow the authorized personnel to audibly assess the situation and determine what actions need to be taken.
   b. All DISA and Security DISA calls shall be automatically recorded by the system for later playback review and/or retrieval by authorized personnel and/or authorities.

17. The system shall provide for field-programmable three-, four-, five-, or six-digit architectural station numbers.

18. There shall be an automatic level control for return speech during amplified-voice communications.

19. Each station loudspeaker shall be assignable to all or any combination of Paging, Time, and/or Audio Zones. Systems that do not provide unlimited Paging, Time, and/or Audio Zones shall not be acceptable.

20. There shall be unlimited schedules with unlimited programmable events per facility. Each event shall sound one user-selected tone or external audio source. It shall be possible to assign each schedule to a day of the week or to manually change schedules from an authorized user via a web-based UI. Systems that do not provide unlimited schedules, events, and tones, or that require software to be installed on a PC to perform these functions shall not be acceptable.
   a. The system shall provide multiple concurrent schedules per facility/location to accommodate split facilities (for example., combined Elementary and Middle School, combined Middle and High School, etc.).
   b. The system must be capable of providing Class Change Music to be played from an external audio source or audio files that are stored in playlists on the system during class change periods or whenever a facility wants music to be played in an area (i.e., one or more Time Zones) on an automated schedule.
   c. Each event shall be able to be directed to any one or more of the unlimited Time Zones.
   d. Each of the unlimited Time Zones shall have a programmable, customizable Preannounce Tone and volume control that is unique unto itself.
   e. Each event shall play any of the Normal tones or external audio. Each event may utilize a different tone. For example, the system shall be capable of sending the gymnasium, shop classes, and pool a separate, unique time tone to indicate “clean up.” Minutes later, the entire facility can be sent a different time tone to indicate class change.
f. Each of the unlimited Time Tones may be manually activated by selected VoIP Admin Phones or via an authorized user with access to the Web UI. These tones shall remain active as long as the telephone remains off-hook or until canceled from the keypad or the Nyquist Web UI.

1) Systems that do not provide an unlimited number of schedules or do not provide automatic activation of schedules shall not be acceptable.

21. Internal Master Clock shall be included, allowing an unlimited number of events per facility. Systems that do not provide an internal master clock or that must supply an external master clock to meet these specifications shall not be acceptable.

22. The Nyquist E7000 is capable of synchronizing with an NTP server and automatically adjusting the Daylight Savings Time for any time zone in the world. The server that the Nyquist E7000 application is running on can also be used as an NTP server for other systems on the LAN (for example, IP Clocks and control systems).

23. There shall be a Zone Page/All-Call Page feature that is accessible by selected Admin Phones and FXO/FXS or SIP connection to the PSTN or PBX/iPBX.

24. There shall be an option to play a pre-announce tone at any loudspeaker selected for voice paging.

25. There shall be a voice-intercom feature that is accessible by CoS authorized staff phones, all Admin VoIP phones, and Admin Web UIs.

a. There shall be a privacy beep played every 15 seconds at any selected loudspeaker to indicate that an intercom call is in progress.

b. There shall be a pre-announce tone played at any selected loudspeaker for intercom call communication.

c. For special applications, the privacy and pre-announce tone signals shall be capable of being disabled during system initialization.

d. There shall be a switch over to private telephone communications should the person at the classroom loudspeaker pick up his or her Staff Station and dial *3 to transfer the call down to the associated classroom Staff Station.

26. There shall be various levels of telephonic communication accessible by all Admin Stations and Staff Stations.

a. Staff Stations must be capable of being programmed to ring one Admin Station during day hours and a different Admin Station during night hours. Day and Night start hours shall be configurable. Staff Stations shall be capable of being assigned to any Admin station. Systems that limit the number and assignment of staff call-ins to an Admin Station shall not be acceptable.

27. Each VoIP speaker or ASB speaker equipped with a call switch (analog or digital) shall be configurable as one of three call-in types, as follows:

a. Normal/Emergency

b. Urgent/Emergency

c. Emergency

28. Call buttons programmed for access Normal / Emergency or Urgent / Emergency shall be able to initiate an Emergency call by repeated flashing of the phone’s hook switch, or repeated pressing of the DCS or the Call Switch. Systems that
require additional switches and/or conductors to initiate an Emergency call, shall not be acceptable.

29. Normal and Urgent calls shall be placed into the queue for the designated Admin Station or Admin Web UI.

30. Each Admin Station call queue shall first be sorted per call priority (for example, Emergency, then Urgent, and then Normal). Calls are sorted within each priority level on a first-in, first-out basis. When a call is answered, it shall automatically be removed from the queue. Systems that do not sort calls per priority and order received shall not be acceptable.
   a. The display shall simultaneously display a minimum of three intercom calls pending.
   b. Additional calls beyond three shall be indicated by a scrolling option on the right-hand side of the screen thus prompting the user that additional calls are waiting.

31. It shall be possible to answer any incoming call by picking up the handset while it is ringing. It shall not be necessary to press any buttons to answer a call unless the call has dropped into the queue.

32. Staff Stations
   a. Staff Stations shall receive a dial tone upon going off-hook. Outgoing calls are made by dialing the desired station. Incoming calls can be directed to the telephone or to the associated loudspeaker for a hands-free reply. There shall be a switchover from loudspeaker to private telephone communication when a person picks up the handset, dials *3, and presses Enter/OK.
   b. Staff Stations shall be programmable for any type of system access, provided by or restricted by the following CoS options:
      1) Call-in Level
      2) Zone Paging
      3) All-Call Paging
      4) Emergency All-Call
      5) Inter-Facility Call/Page
      6) Audio Distribution
      7) Remote Pickup
      8) Join Conversation
      9) Call Forwarding
      10) Walking Class of Service
      11) External Call Routing
      12) Call Transfer/3-way Calling
      13) Manually Activate Tone Signals
      14) Call Any Station
      15) Manage Recordings
      16) Monitor Calls
      17) Monitor Locations
      18) Conference Admin
      19) Conference User
      20) Voicemail
      21) Record Calls
      22) Activate Alarm Signals
      23) Disable Audio
      24) Enable Audio
25) Allow Callee Auto-answer
26) District Paging
27) Inter-Facility Features
28) Manage Output Contacts
c. Staff Stations shall be able to make a Normal call to any Admin Station by dialing the Admin Station’s extension number. Staff Stations shall also be able to initiate an Emergency Call by dialing ****. Emergency Calls shall ring the Designated Day/Night Admin Station. The system shall provide for each station to have a Personal Identification Number (PIN). By dialing the PIN at any system telephone, the administrator shall have access to Emergency paging regardless of the restrictions on the particular phone being used.

33. Admin Stations
a. Admin Stations shall receive a dial tone upon going off-hook. Outgoing calls are made by dialing the desired stations. Incoming calls can be directed to the telephone or to the associated loudspeaker for a hands-free reply. There shall be an automatic switchover from loudspeaker to private telephone communication should the person pick up his or her handset.
b. The display shall normally show the time of day and day of week, bell schedule name, and the numbers of a minimum of three stations calling-in, along with the call-in status of each station (Normal, Urgent, Emergency). The Admin Station’s display shall indicate the station number being dialed from the Admin Station.
c. The display shall also provide user-friendly menu selections to assist the operator when using the Nyquist system. Displays shall be in English for maximum ease-of-use. Systems that require the operator to memorize long lists of operating symbols or control codes shall not be acceptable.
d. Admin Stations shall be programmable for any type of system access, providing or restricting the following CoS options:
1) Call-in Level
2) Zone Paging
3) All-Call Paging
4) Emergency All-Call
5) Inter-Facility Call/Page
6) Audio Distribution
7) Remote Pickup
8) Join Conversation
9) Call Forwarding
10) Walking Class of Service
11) External Call Routing
12) Call Transfer/3-way Calling
13) Manually Activate Tone Signals
14) Call Any Station
15) Manage Recordings
16) Monitor Calls
17) Monitor Locations
18) Conference Admin
19) Conference User
20) Voicemail
21) Record Calls
22) Activate Alarm Signals
23) Disable Audio
24) Enable Audio
25) Allow Callee Auto-answer
26) District Paging
27) Inter-Facility Features
28) Manage Output Contacts

e. Program selection and its distribution or cancellation shall be accomplished from a designated Admin Station with the assistance of the menu display system. Distribution and cancellation shall be to any one or combination of speakers, any Audio Zone or Audio Zones, or All Zones. It shall be possible to provide an unlimited number of program channels for the user to pick from.

f. It shall be possible via an Admin Station to manually initiate any of the unlimited Normal Tones or Emergency Tones. The Tones shall be separate and distinctly different from the Alarm Tones. The Tone selected shall be capable of being played one time, continuously until it is canceled, or until the administrative display phone is placed back on-hook.

g. Each Admin Station shall maintain a unique queue of all stations calling that Admin VoIP phone.

34. System programming shall be from an authorized Nyquist Admin User via any web browser. A valid username and password shall be required to gain access to the following programmable functions:
a. System Parameters – Allow installers to adjust core system parameters.
b. Zones – Allow installers to create and modify Paging, Time, and Audio Zones.
c. Schedules – Allow installers and administrators to create Bell Schedules for the facility, predefine alternative schedules to run. Holiday Events prevent the bells from ringing on a school holiday. The system shall allow an unlimited number of schedules to operate simultaneous within a facility.
d. Admin Groups – Allow the installer to create, modify, and delete software groupings of admin phones that can ring when a station calls in with a call switch.
e. CoS Configuration – Allow the installer to create, modify, and delete CoS groups that can have the following features defined: Call in Level, Zone Paging, All-Call Paging, Emergency All-Call, Inter-Facility Call/Page, Audio Distribution, Remote Pickup, Join Conversation, Call Forwarding, Walking Class of Service, External Call Routing, Call Transfer/3-way Calling, Manually Activate Tone Signals, Call any Station, Manage Recording, Monitor Calls, Monitor Locations, Conference Admin, Conference User, Voicemail, Record Calls, Activate Alarm Signals, Disable Audio, Enable Audio, Allow Callee Auto-answer, District Paging, and Inter-Facility Features.
f. Stations – Allow the installer to set up, modify, delete stations, set up Page Exclusion, view stations’ status, and add a station.
g. Bridge Devices – Allow the installer to install the Nyquist ASBs.
h. Audio – Allow the installer to upload and manage Announcements, Playlists, Announcements, Songs, and Tones. The must support the
uploading of both MP3 and WAV files making Audio file management simple for users. Systems that limit the size of Audio files shall not be considered equal.

i. Users – Allow the installer to manage users by giving them the proper Role and assign an Extension if needed.

j. Roles – Allow the installer to limit user to the following: create, delete, edit, restart server, sort menu, systems update, manage, import/export, restore, settings, or view.

k. Facilities – Allow the installer to set up the district wide facilities for remote paging and calling.

l. Outside Line – allow the installer to set up FXS and FXO ports for inbound and outbound system calling.

m. SIP Trunks – allow the installer to set up SIP trunks into the facility for inbound or outbound calling.

n. Call Details – allow the installer to review the historical system activities that can be used for incident investigation or system troubleshooting.

o. System Backup/Restore – allow the installer to perform system backup or restores and allow the backups to be scheduled to run automatically.

p. System Logs – allow the installer to view and export Server, Nyquist-Intercom, and Web Server logs that can be used for trouble shooting and technical assistance.

q. Paging Exclusions – allow the installer to view and edit station that are excluded from paging.

r. Firmware – is used to update Nyquist appliances.

s. Help – Provides information about the system, online help topics, and System Administrator Manual.

t. Systems not capable of supporting web-based configuration and control, or require plugins or dedicated application software, shall not be deemed as equal.

u. Systems that require a Serial-to-Ethernet converter, or require additional application software on a PC for configuration and/or control shall not be deemed as equal.

35. Admin Group

a. Admin Stations can be placed into Admin Groups, which are used if incoming calls are not answered by the assigned Admin Station or the Day or Night Admin associated with the Admin Station. Admin Groups act as an always answer feature by providing an alternate list of Admin Stations. If an incoming call is not answered by the assigned Admin Station within 30 seconds for normal calls or 15 seconds for emergency calls, all Admin Stations in the Admin Group will ring.

b. If Call Forwarding is enabled at the Admin Station, Nyquist tries the forwarded extension. If that station does not answer or is busy, the call timeout is reduced to 15 seconds. After 15 seconds, the call rolls over to the Admin Group.

c. If an Emergency level call receives no answer, the Admin Group will ring if the Day Admin or Night Admin does not answer.

d. Admin Stations can be assigned to multiple Admin Groups. A Day or Night Admin can also be assigned to one or more Admin Groups.

36. Call Detail Reporting
a. The Call Details feature allows the viewing and/or printing of detail records of every call in a facility in a call log format. Calls include scheduled announcements, paging, and internally and externally made or received telephone calls.

37. System Backup/Restore  
a. The system backup feature allows users with access to back up the system database, voicemail, and recordings.  
b. The system restore allows users with access to perform a system restore of previously backed up database, voicemail, and/or recordings.  
c. The installer also can set up an automatic backup that can be performed daily, weekly, or monthly.

38. System Log Files  
a. A log file records either events or messages that occur when software runs and is used when troubleshooting the system. The following parts of the Nyquist system generate log files:  
1) Server (This provides access to the Debian Linux OS server log files.)  
2) Intercom (This provides access to the Intercom application server log files.)  
3) Web Server (This provides access to the web server log files.)  
b. From the web-based UI, system logs can be viewed directly or exported via download to a PC, Mac, or Android device and then copied to removable media or attached to an email to technical support.

39. Paging Exclusions  
a. For school testing and exams, the administrators shall be able to put stations into Page Exclusion mode. During this time, the stations will only receive Emergency All-Call pages – not music, tones, or All-Calls. Emergency pages will still be heard at the station even if that station is set to exclude paging.

PART 3 - EXECUTION

3.1 EXAMINATION  
A. Examine conditions, with the installer present, for compliance with requirements and other conditions affecting the performance of the Nyquist E7000 Series Educational System.  
B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 EQUIPMENT MANUFACTURER'S REPRESENTATIVE  
A. All work described herein to be done by the manufacturer's authorized representative shall be provided by a documented factory authorized representative of the basic line of equipment to be utilized.  
B. As further qualification for bidding and participating in the work under this specification, the manufacturer's representative shall hold a valid C-10 Contractor's License issued by the Contractor's State License Board of Texas. The manufacturer's representative shall have completed at least 3 projects of equal scope, giving satisfactory performance, and shall have been in the business of furnishing and installing sound systems of this type for
at least five years. The manufacturer's representative shall be capable of being bonded to ensure the owner of performance and satisfactory service during the guarantee period.

C. The manufacturer's representative shall provide a letter with submittals from the manufacturer of all major equipment stating that the manufacturer's representative is an authorized distributor. This letter shall also state that the manufacturer guarantees service performance for the life of the equipment and that there will always be an authorized distributor assigned to service the area in which the system has been installed.

D. The contractor shall furnish a letter from the manufacturer of the equipment. This letter shall certify that the equipment has been installed according to factory intended practices, that all the components used in the system are compatible, and that all new portions of the systems are operating satisfactorily. Further, the contractor shall furnish a written unconditional guarantee, guaranteeing all parts and all labor for a period of five years after final acceptance of the project by the owner.

3.3 DIVISION OF WORK

A. While all work included under this specification is the complete responsibility of the contractor, the following division of actual work listed shall occur:
   1. The conduit, outlets, terminal cabinets, etc., which form part of the rough-in work, shall be furnished and installed completely by the electrical contractor.
   2. The balance of the system, including installation of speakers and equipment, making all connections, etc., shall be performed by the manufacturer's authorized representative. The entire responsibility of the system, its operation, function, testing and complete maintenance for one year after final acceptance of the project by the owner, shall also be the responsibility of the manufacturer's authorized representative.

3.4 INSTALLATION

A. The installation, adjustment, testing, and final connection of all conduit, wiring, boxes, cabinets, etc., shall conform to local electrical requirements and shall be sized and installed in accordance with the manufacturer’s approved shop drawings.

B. Low-voltage wiring may be run exposed above ceiling areas where they are easily accessible.

C. The contractor shall install the new system at the location shown on the plans.

D. All Staff Stations and Call Switches shall be wall-mounted:
   1. Mount at 48" AFF.
   2. All wiring should be concealed.
   3. Verify exact location with architect.
   4. Avoid mounting near doors to prevent students from activating and running out of the rooms.

E. Admin Stations can be desk or wall mounted.

F. Speaker and telephone lines run above ceiling and not in conduit shall be tie-wrapped to a ceiling joist with a maximum spacing of 8’ between supports. No wires shall be laid on top of ceiling tile.

G. Connect field cable to each Analog Speaker transformer using UL butt splices for #22 AWG wire.
H. Contractor shall provide a minimum of eight hours of configuration and operational instruction to school personnel.
   1. Bogen Communications, Inc., shall provide online “How To” videos for instructing the teaching staff on how to operate the Teacher Dashboard aspect of the system.

I. On the first school day following installation of the Nyquist System, the contractor shall provide a technician to stand by and assist in system operation.

J. Mark and label all demarks IDF and MDF points with destination point numbers. Rooms with more than one outlet shall be marked XXX-1, XXX-2, XXX-3, etc. where XXX is the room number.

K. No graphic room number shall exceed the sequence from 000001 through 899999.
   1. All outside speakers shall be on a separate Page Zone and Time Zone.
   2. All zones shall be laid out not to exceed 40 Watts (@25V) maximum per zone.
   3. All hallways speakers shall be tapped at 1 Watt (@25V) maximum.
   4. All outside horns shall be tapped at 3.75 Watts (@25V) maximum.
   5. All classroom speakers shall be tapped at ½ Watt (@25V) maximum.
   6. Large rooms, such as cafeterias, shall be tapped at 2 Watts (@25V) maximum.

L. Plug disconnect: All major equipment components shall be fully pluggable by means of multi-pin receptacles and matching plugs to provide for ease of maintenance and service.

M. Protection of cables: Cables within terminal cabinets, equipment racks, etc., shall be grouped and bundled (harnessed) as to type and laced with No. 12 cord waxed linen lacing twine or T and B wire-ties, or hook and loop cable management. Edge protection material shall be installed on edges of holes, lips of ducts, or any other point where cables or harnesses cross a metallic edge.

N. Cable identification: Cable conductors shall be color-coded and individual cables shall be individually identified. Each cable identification shall have a unique number located approximately 1-1/2" from cable connection at both ends of cable. Numbers shall be approximately 1/4" in height. These unique numbers shall appear on the As-Built Drawings.

O. Shielding: Cable shielding shall be capable of being connected to common ground at point of lowest audio level and shall be free from ground at any other point. Cable shields shall be terminated in the same manner as conductors.

P. Provide complete “in service” instructions of system operation to school personnel. Assist in programming of telephone system.

3.5 GROUNDING

A. The contractor shall provide equipment grounding connections for Integrated Telecommunications/Time/Audio/Media System as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to ensure permanent and effective grounds.

B. The contractor shall provide ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

C. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
D. The contractor shall note on their drawings the type and locations of these protection devices and all wiring information.

E. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

3.6 DOCUMENTATION

Provide the following directly to the Supervisor of Technology Services.

A. One printed copy of all field programming for all components in system

B. One copy of all diagnostic software with a copy of field programming data for each unit

C. One copy of all field wiring runs, location, and end designation of system

END OF SECTION – 27 41 16
SECTION 28 05 29 - HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Conduit supports.
   2. Formed steel channel.
   4. Sleeves.
   5. Mechanical sleeve seals.
   6. Firestopping relating to electrical work.
   7. Firestopping accessories.
   8. Equipment bases and supports.

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.

1.2 REFERENCES

A. ASTM International:

B. FM Global:

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   5. UL - Fire Resistance Directory.

E. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.
1.4  SYSTEM DESCRIPTION
A. Firestopping Materials: UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

1.5  PERFORMANCE REQUIREMENTS
A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6  SUBMITTALS
A. Section 01 30 00 - Submittals: Requirements for submittals.
B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
F. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.
G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7  QUALITY ASSURANCE
A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 – Material and Equipment: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer’s identification.
C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS
A. Section 01 60 00 – Material and Equipment: Environmental conditions affecting products on site.
B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
D. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS
2.1 CONDUIT SUPPORTS
A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
D. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
E. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL
A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS
A. Product Description: Mounting hole and screw closure.

2.4 SLEEVES
A. Sleeves for conduit Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
B. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 FIRESTOPPING
A. Manufacturers:
   1. Dow Corning Corp.
   2. Hilti Corp.
3. Substitutions: Section 01 60 00 – Material and Equipment

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 50 00 – Construction Facilities and Temporary Controls: Verification of existing conditions before starting work.
B. Verify openings are ready to receive sleeves.
C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
B. Remove incompatible materials affecting bond.
C. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide precast inserts, expansion anchors and preset inserts.
   2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
   3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
   5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
   7. Wood Elements: Provide wood screws.

B. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.
D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
E. Install multiple conduit runs on common hangers.
F. Supports:
   1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
   2. Install surface mounted cabinets and panelboards with minimum of four anchors.
   3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.

3.4 INSTALLATION - FIRESTOPPING
A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

3.5 INSTALLATION - SLEEVES
A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
C. Set sleeves in position in forms. Provide reinforcing around sleeves.
D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

3.6 FIELD QUALITY CONTROL
A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.7 CLEANING
A. Section 01 70 00 – Contract Closeout: Requirements for cleaning.
B. Clean adjacent surfaces of firestopping materials.

3.8 PROTECTION OF FINISHED WORK
A. Section 01 70 00 – Contract Closeout: Requirements for protecting finished Work.
B. Protect adjacent surfaces from damage by material installation.

END OF SECTION – 28 05 29
SECTION 28 05 33 - CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND
SECURITY

PART 1 GENERAL

1.1 SUMMARY
A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and
junction boxes, and handholes.

1.2 REFERENCES
A. American National Standards Institute:
   1. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and
      Cable Assemblies.
   3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box
      Supports.
   4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 DESIGN REQUIREMENTS
A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.4 SUBMITTALS
A. Section 01 30 00 - Submittals: Submittal procedures.
B. Product Data: Submit for the following:
   1. Flexible metal conduit.
   2. Nonmetallic conduit.
   3. Raceway fittings.
   4. Conduit bodies.
   5. Wireway.
   6. Pull and junction boxes.
C. Manufacturer's Installation Instructions: Submit application conditions and limitations of
   use stipulated by Product testing agency specified under Regulatory Requirements.
   Include instructions for storage, handling, protection, examination, preparation, and
   installation of Product.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide
   appropriate covering.
B. Protect PVC conduit from sunlight.

1.6 COORDINATION
A. Section 01 50 00 – Construction Facilities and Temporary Controls: Coordination and
   project conditions.
B. Coordinate mounting heights, orientation and locations of outlets mounted above
   counters, benches, and backsplashes.
PART 2 PRODUCTS

2.1 FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. Alflex.

B. Product Description:
   1. Usage restrictions:
      a. As per NEC Article 348.
      b. Flexible metallic conduit shall not be used as the general wiring system.
      c. The Engineer shall be consulted on all questions regarding the use of
         flexible conduit and shall interpret the intent of the Specifications
         regarding the locations for which flexible conduit is allowed.
   2. Approved for general use in the following situations or locations:
      a. Interwiring of millwork and cabinets for feeds to outlet boxes.
      b. Locations where equipment, ductwork, structure, or other hindrance
         makes it impractical or impossible to install straight or offset tubing or
         conduit. This provision does not provide for the use of flexible conduit
         where improper prior planning or delay in conduit installation make the
         location subsequently inconvenient for the use of straight or offset runs
         of conduit or tubing.
   3. The use of flexible conduit in old work is extended to include installation of
      conduits fished in existing walls or other special or unusual situations approved
      by the Engineer.
   5. Used with fittings specifically approved for use with flex.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. LTV Steel Tubular Products.
   2. Allied Tube and Conduit.

B. Product Description:
   1. Usage restrictions per NEC.
   2. Used for above-grade wiring only. EMT is not permitted in slabs or below grade.
   3. Used to enclose:
      a. General equipment feeds.
      b. Communications wiring or cabling.
      c. Control wiring.
      d. Similar types of wiring unless noted otherwise in the specifications or on
         the Drawings.
   4. Galvanized mild strip steel with interior UL approved coating.
   5. Fittings:
      a. The following types of fittings, couplings, and connectors may be used:
         1) Die-cast non-insulted zinc compression type.
         2) Steel non-insulated compression type.
         3) Conduits trade size 1-1/4” and smaller may have set screw
            fittings where used in dry interior locations only if the circuit
            contains a separate grounding conductor.
      b. The following types of fittings, couplings, and connectors are prohibited:
1) Expanded conduit ends with factory pre-installed set-screw attachments.
2) Indentor type.
3) Set-screw type.

2.3 NONMETALLIC RIGID CONDUIT (PVC)

A. Manufacturers:
   1. Carlon Electrical Products.
   2. Can-Tex.

B. Product Description:
   1. Usage restrictions per NEC Article 352
   2. General requirements:
      a. Polyvinyl chloride compound.
      b. Schedule 40-wall thickness.
      c. Flame retardant type.
      d. Resistant to bending and cracking.
      e. UV resistant.
   3. Used for horizontal runs of underslab or underground conduits. Vertical risers and all ells installed below grade must be rigid steel installed as noted previously.
   4. No above ground installation.
   5. Couplings and fitting designed for permanent glued connection to the conduit.

2.4 INTERIOR OUTLET AND JUNCTION BOXES

A. Manufacturers:
   1. Steel City.
   2. Raco.
   3. Appleton.

B. Standard interior outlet boxes for connection to concealed conduit raceways, or for exposed surface mounted conduit raceways in mechanical spaces, electrical rooms, and similar non-public areas:
   1. General requirements:
      a. Of proper size and shape for conduits and conductors entering them.
      b. UL and NEC listed for their application.
      c. Constructed of code gauge steel.
      d. Galvanized or plated.
      e. Complete with conduit knockouts (boxes 4” square and smaller).
   2. A minimum of 1-1/2” deep unless the following conditions are met:
      a. Construction requires a smaller depth box.
      b. Engineer specifically approves the use of such shallow boxes.
      c. Depth is not reduced below 1-1/4”.
   3. Box construction:
      a. Formed (drawn) one piece, for single gang boxes.
      b. Formed (drawn) one piece or stamped and welded for double gang boxes.
      c. Formed (drawn), stamped and welded, or sectional type for boxes greater than 2 gang.
d. Masonry type stamped and welded boxes (with continuous overlapping device screw attachment trim) may be used where recessed in concrete or concrete block (CMU) wall construction.

4. Box size:
   a. 4” square for up to two devices and solid ganged boxes for over two devices.
   b. Single gang “handy boxes” may be used for device boxes in limited areas (such cabinet work) only with the Engineer’s permission. Do not use bevel corner boxes.
   c. 4-11/16” square boxes for specific devices (such as fire alarm equipment) where required. Consult with manufacturer to determine use and location of special boxes.

C. Standard interior outlet boxes for connection to surface mounted two piece raceway systems:
   1. Stamped enamel painted steel.
   2. Of proper size and shape for surface raceways and conductors entering them.
   3. UL and NEC listed for their application.
   4. A minimum of 1-1/2” deep unless a shallower device box is approved.
   5. Single gang unless used for two devices.

D. Interior junction boxes mounted above the ceiling line for connection and distribution of branch circuit wiring to receptacles, lighting fixtures, and small motor loads shall be of the same type as standard 4” square outlet boxes except that they shall have flat steel covers.

2.5 CAST BOXES

A. Manufacturers:
   2. Appleton.

B. Where specified on the Drawings or required for surface mounted exterior or wet interior locations, provide cast outlet boxes.

C. Cast outlet box standards:
   1. Threaded hub type with drilled mounting lugs.
   2. Constructed of ferrous (malleable iron) alloy.
   3. Equal to Crouse-Hinds “Condulet” or Appleton “Unilet” type. Fixture outlet boxes equal to type VFX or GRF type; wiring device outlet boxes equal to type FS or FD.
   4. Provide with plugs for all unused openings, gaskets, and covers compatible with the function of the box.
   5. Where required to be coated for corrosion resistance, provide as follows:
      a. Permanently fused to galvanized surface. Coatings that require the galvanized surface to be compromised prior to application of the coating are not acceptable.
      b. Smooth and continuous.
      c. Comply with NEMA RN1 and applicable ASTM standards for immersion in boiling water and application of humidity and acetone.
      d. Exterior coating:
         1) Field strippable.
         2) Nominal 40-mil thickness of polyvinyl chloride (PVC).
         3) Applied after the surface has been primed to receive the coating.
e. Interior coating:
   1) Permanently coated.
   2) Nominal 2-mil thickness of polyurethane.
   3) Resistant to abrasion from pulling of conductors through conduit.

2.6 PULL AND JUNCTION BOXES
A. Manufacturers:
   1. Hoffman.
   2. Wiegmann.
   3. Milbank.
B. Install:
   1. Where noted on the Drawings.
   2. Where the total number of bends exceeds 360 degrees.
   3. At other locations required by the NEC.
C. Use boxes constructed of code gauge steel with standard size knockouts or suitable for field drilling.
D. Provide junction or pull boxes required by the Drawings or by codes larger than the standard 4” square where required.

2.7 EXTERIOR GRADE PULL AND JUNCTION BOXES
A. Manufacturers:
   1. Strongwell Quazite.
   2. Newbasis.
   3. Carson.
B. Provide where required for termination and intermediate pulling access.
C. General requirements:
   1. Polymer cast concrete construction reinforced with fiberglass. Plastic construction is not acceptable.
   2. Designed for flush grade mounting.
   3. Solid wall construction without knockouts unless approved otherwise.
   4. Load ratings:
      a. General Duty UL Tier 5 for grassy and pedestrian traffic areas.
      b. Heavy Duty UL Tier 10 for sidewalks, driveways, and similar areas accessible to vehicular traffic.
   5. Lid:
      a. Single or two-piece.
      b. Attached with stainless recessed head bolts.
      c. Logo as directed, molded into top of lid.
   6. Bottom:
      a. Provide bottom in box where noted.
      b. Provide open bottom if not noted.
   7. See Drawings for sizes required.
2.8 FIRE SEALING REQUIREMENTS

A. All electrical penetrations through fire rated walls, floors, and ceilings shall be fire sealed to prevent the propagation of smoke and fire, regardless of whether they are enclosed by a raceway or not.

B. Provide fire sealing in all locations required by applicable Codes.

C. Utilize materials suitable for the intended service.

D. Fire sealing shall be provided for both raceway and free-wired low voltage cabling through firewalls or fire barriers.

E. Generally required UL ratings:
   1. Floors:
      a. Utilize FA rating for concrete floors less than 5 inches thick.
      b. Utilize FB rating for concrete floors more than 5 inches thick.
      c. Utilize FC for wood framed floors.
   2. Walls:
      a. Utilize WL rating for framed walls.
      b. Utilize WJ rating for concrete or masonry walls less than 8 inches thick.
      c. Utilize WK ratings for concrete or masonry walls more than 8 inches thick.

F. Putties and sealants:
   1. Utilize for openings of less than 6 inches in diameter.
   2. Generally preferred method for sealing conduit penetrations through walls, ceilings, and floors.
   3. May be manufactured in caulk tubes, sticks, buckets, or similar manner to allow easy field insertion for fire stopping.
   4. Communication wiring and similar seals must remain permanently soft to allow reuse and re-entry into the sealed opening. Seals for permanent conduit penetrations may become hard after installation.
   5. Do not use materials that give off toxic fumes when curing.
   6. UL listed for the same rating as the wall the raceway penetrates (typically 1 or 2 hours).

G. Pipe wrap:
   1. Utilize for conduit penetrations of walls, floors, and ceilings.
   2. May be used instead of putties and sealants where approved by the Engineer.
   3. Intumescent type that expands upon being heated.

H. Floor-to-floor conduit sleeves:
   1. Provide rigid steel conduit sleeves where installed for upper wood or precast concrete tee floors.
   2. Provide fire stop assembly for cast-in-place applications where above grade concrete floors are poured in place on site. Assembly requirements:
      a. Plastic sleeve with integral rubber gasket and intumescent ring of fire stopping material to provide both fire and smoke sealing.
      b. Top plug to exclude concrete during pouring of slab and dust and dirt after installation is completed.
      c. Suitable for replacement of conduit once installed without replacement of assembly.
      d. Suitable for use in floors between 2.5” and 6” of thickness.
      e. Resistance to normal temperatures up to 100 deg. C.
      f. Equal to Hilti CP 680 series.
2.9 CORROSION PROTECTIVE TAPE

A. General requirements:
   1. Use for any metallic conduit installed in concrete or below grade.
   2. Pressure sensitive PVC based type suitable for direct burial applications.
   3. Impact resistant
   4. Resistant to moisture, acids, salt, and alkalies.

B. Equal to Scotch #50 or #51.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 FIRE SEALING REQUIREMENTS

A. Install fire sealing in all locations required by applicable Codes.

B. Fire sealing shall be installed for all raceway and sleeve penetrations of fire rated walls, ceilings, or floors above grade.

C. Fire sealing shall consist of fire rated putty, sealants, boards, poured or sprayed materials, pillows, or sheets of fire sealing material of required sizes and quantities to completely and effectively seal the associated fire barriers.

D. Wall penetrations of conduit shall generally be sealed with putty or caulk type sealant. Thoroughly seal penetration to avoid any air spaces around the wall penetrations.

E. Floor penetrations shall be sealed as follows:
   1. For wood floors and pre-cast steel concrete tees:
      a. Install rigid steel nipple through concrete floor. Stub both above and below floor line approximately 1 inch.
      b. Securely attach nipple with pipe clamps or other suitable method to prevent nipple from shifting.
      c. Pack between nipple and concrete opening with ceramic fiber or mineral wool for areas not requiring fire-stopping putty.
      d. Install fire-stopping putty at top and bottom of penetration. Thickness shall be as recommended by manufacturer.
   2. For cast-in-place concrete floor and concrete floors above metal decks with total floor thickness between 2.5” and 6.0” with dimensions of sleeves up to 4” in diameter:
      a. Provide pre-manufactured firestop assembly instead of field fabrication method noted previously.
      b. Assembly shall be Hilti #CP 680 series or other approved by the Engineer.
      c. For total concrete construction:
         1) Attach bottom flange to bottom floor form with top of shaft above top of concrete pour.
         2) Close all openings with temporary plugs.
         3) Support assembly prior to pour to prevent movement.
         4) After floor is poured, cut off top of assembly flush with floor line and re-insert top plug.
      d. For concrete topping slab installed on top of metal decking:
1) Cut circular hole through decking and install metal deck adapter for assembly.
2) Attach bottom flange of assembly to deck adapter and to screw bottom flange to deck. Place with top of assembly shaft above top of concrete pour.
3) Close all openings with temporary plugs.
4) Support assembly prior to pour to prevent movement.
5) After floor is poured, cut off top of assembly flush with floor line and re-insert top plug.

F. Install all fire seal materials in accordance with manufacturer’s recommendations and NEC Article 300-21.

3.3 INSTALLATION- RACEWAY

A. Install all wiring in NEC approved raceways (unless specifically approved otherwise) sized as shown on the Drawings, or, if not sized on the Drawings, in accordance with NEC conduit fill tables.

B. Install raceway systems in a neat, straight, and workmanlike manner complete with all J-boxes and pull boxes as necessary or noted on plans.

C. Raceway general installation notes:
1. All raceways are to be concealed unless noted or approved otherwise.
2. Run concealed conduits as follows:
   a. Straight and parallel to building lines where installed in walls and above ceiling lines.
   b. In a direct line (unless interferences with other trades prevent) where installed under slabs or below grade.
   c. Do not run conduit horizontally in concrete block (CMU) walls, whether cells are filled or unfilled. Conduits must run vertically inside the CMU cells and be fed from overhead or underground, as appropriate.

3. Exposed or surface raceways:
   a. Difficulty in installing concealed conduit in existing or new construction is not in itself reason for installing surface raceways in lieu of concealed conduit.
   b. Surface raceways shall generally be installed only in the following locations:
      1) Existing mechanical or boiler rooms.
      2) New outlets on existing solid masonry walls.
      3) Raceway is installed on the roof.
   c. Install only at right angles to the building lines.
   d. Conceal the appearance as best as possible even if this requires additional materials or longer routes. Homerun for outlet boxes on interior or exterior walls shall generally be run:
      1) From the outlet box down to accessible floor or tunnel space.
      2) From the outlet box to the room corner and then up to the accessible ceiling space.
      3) Do not run homeruns vertically from each outlet box.
   e. Confirm the exact routing of any exposed raceways in the field with the A/E prior to roughing in.

4. Do not install wiring in exit stairwells except for that wiring associated with the stairwell itself (such as lighting or ADA communication systems).

D. Mechanical details of conduit and raceway installation:
1. Make all cuts squarely, ram after cutting, and butt conduits solidly into fittings.
2. All conduit and raceway systems must be mechanically continuous and installed complete before conductors are pulled.
3. Bend conduit with approved bending devices. Remove and replace deformed or damaged conduit.
4. Temporarily plug opening if conductors are not immediately installed in the raceway. Install plugs to exclude plaster or other foreign materials.

E. When a metallic conduit enters an enclosure, provide an insulated throat connector and or an insulating bushing where the conduit contains conductors sized #4AWG or larger.

F. Do not run conduit or raceway adjacent to steam piping or hot vent piping unless authorization is provided.

G. Sleeves:
   1. Install where noted on the Drawings.
   2. Provide for conduit entrances into exterior building walls below grade as follows:
      a. Provide steel conduit sleeves, cutouts, chases or knockouts for passage of the raceways through the exterior wall(s).
      b. Sleeves or knockouts shall be of adequate size to allow for reasonable settlement or movement of the raceway or building wall without damage to the enclosed conduits and wiring.
      c. Completely seal all sleeves, chases, or knockouts to prevent moisture from entering basement areas or from migrating under footings.
      d. Steel sleeves significantly larger than the enclosed conduit shall have a steel plate welded to the exterior of the sleeve to properly close the wall opening prior to waterproofing.
      e. Consult the Engineer for determination of specific problem resolution which may include special construction.

3.4 INSTALLATION - UNDERGROUD RACEWAY

A. Carefully plan excavations for electrical systems and utilities in advance, paying particular attention to other utilities in the project area, both existing and new. Use hand and/or machine excavation cautiously to prevent damage to installed systems. The Contractor is responsible for repairing all damages caused as a result of excavation.

B. Standard conduit depths:
   1. Slightly less than 60” deep for utility primary cables and conduits where ditching is provided by the Contractor.
   2. Minimum of 36” below grade outside of the building lines for service entrance and feeder circuits.
   3. Minimum of 24” below grade outside of the building lines for branch circuit conduits.
   4. Below concrete building slabs:
      a. Conduits installed under sidewalks, driveways, porches, and similar areas outside of the main building slab shall maintain the minimum depths listed above.
      b. Conduit installed under the main building slab:
         1) Do not install horizontal conduit runs in the slab itself.
         2) Place conduit in sand cushion region below the building slab or place in the lower soil below the sand cushion.
         3) Conduits placed in the lower soil shall have their surrounding ditch area filled with compacted sand with the bottom of the conduit placed at least 1” above the bottom of the ditch soil.
4) Adjust conduit depth so there is adequate room to turn up risers so that risers are vertical after passing through the top surface of the slab.

C. Ditch backfill:
1. Backfill with “flowable fill”:
   a. Flowable fill shall contain Portland cement, water, fly ash, and fin aggregate.
   b. Portland cement:
      1) Mix shall contain a minimum of 3.5 sacks of Portland cement per cubic yard of fill.
      2) Type I or type II conforming to ASTM C150 or ASTM C595.
   c. Fly ash shall conform to ASTM C618 Class C or Class F. Fly ash may be eliminated only with written approval of the Engineer.
   d. Batching and mixing shall conform to ASTM C94. Place with chutes, conveyors, or pumps.
   e. Flowable fill shall “flow” with little head or mounding, with a slump of approximately 10” to 11”.
   f. 28-day compressive strength shall be no more than 100 psi and no less than 75 psi.
   g. Depth of flowable fill:
      1) Asphalted areas: Entire ditch depth except for within 7.5” of final grade.
      2) Grassy areas. Entire ditch depth except for within 12” of final grade.

D. Tracer wire:
1. Provide and install in conduit ditches for spare or unused conduits.
2. Install one #12AWG solid copper THHN/THWN insulated conductor in the ditch with the conduit.
3. Temporarily attach the tracer wire to the outer top surface of the conduit to keep the tracer wire from falling off of the conduit and into the ditch prior to backfilling. Utilize electrical tape, duct tape, or similar material for attachment of tracer wire.
4. Stub up tracer wire above grade on each end of conduit run as the conduit penetrates grade level. Provide loop of wire at each end to allow for future easy attachment of tracer equipment. Attach wire loops to sides of conduit.
5. Internal pull wire may not be substituted for tracer wire.
6. Tracer wire is required outside of the building slab perimeter for non-metallic conduits only under the following conditions:
   a. Empty service entrance and feeder non-metallic conduits installed without conductors and in a direction other than that of other service entrance of feeder conduits (spare or empty conduits run with active conduits do not require tracer wires).
   b. Active or inactive conduits for fiber optic cables.

E. Ditch marking tape:
1. Install in the ditch where utility or service entrance conduits are buried outside the building perimeter.
2. Tape is not required for exterior branch circuit ditches.
3. Install approximately 6” to 12” below final grade.
4. Tape requirements:
   a. Equal to 6 ply extra stretch “Terra-Tape 540” manufactured by Reef Industries, Inc.
b. Nominally 6” wide.

c. Yellow or red background with black block letters continuously printed with the statement “Caution Electric Line Buried Below” or similar acceptable wording.

3.5 INSTALLATION- PVC RACEWAY

A. Joints:
1. Thoroughly clean conduit and fitting or coupling prior to application of glue.
2. Utilize solvent type glue compound, which will provide a watertight permanent joint by welding both PVC surfaces together.
3. Do not use aerosol or spray-on joint compound.

B. Bends and offsets:
1. Make any PVC field offsets with a hot box bender specifically approved for the purpose.
2. PVC offsets of less than 45 degrees may be field or factory made.
3. Install factory PVC bend where angle of bend is 45 degrees or more.
4. Provide rigid steel or IMC factory ell or offset in conduit run, instead of PVC, where:
   a. Conduits 2” trade size or larger.
   b. Length of run exceeds 125 ft.
   c. Ropes larger than ¼” diameter are used for pulling conductors.
   d. Any location where the installation of the conductors may pull through the interior wall of PVC elbows or offsets.

C. Transition to the type of metallic conduit used above grade or above slab as the PVC conduit passes through the grade or slab.

D. Protection of steel fittings, couplings, elbows, and offsets utilized below grade in PVC conduit runs:
1. Protect metallic conduit and fittings with either factory-applied coating or field applied coating.
2. Coatings or fitting skirts shall extend past the metallic conduit or fittings onto the PVC conduit run to make a watertight seal.
3. Field applied tape coatings:
   a. Overall coating must be a minimum of 20 mils thickness.
   b. Provide at least one half-lapped layer of Scotch #50 (10 mil) tape or one layer of Scotch #51 (20 mil) tape with overlapped edges.
   c. Prime conduit with Scotch Pipe Primer (or equal) prior to application of tape.

3.6 INSTALLATION- HDPE RACEWAY

A. Lay the conduit in the ditch as straight as possible, taking care to avoid “snaking” of conduit.

B. Conduit shall be installed complete, end-to-end, without joints in the HDPE run. If conduit installed is too short, replace with single continuous run.

C. Take precautions to avoid deforming the internal diameter of the conduit. Any conduit which is kinked or has excess “ovaling” shall be removed and replaced.

D. Provide couplers where transitioning from HDPE to PVC or steel conduit. Coupler installation:
1. Thoroughly clean conduit and fitting or coupling prior to application of couplers
2. Prepare cut conduit ends by beveling the outside edge of the conduit prior to inserting into the coupler.
3. Remove any stray burrs or conduit shavings with a deburring tool.
4. Install coupler onto conduits at the correct docking depth. Tighten stainless steel bands to provide a watertight joint.

E. Transition to the type of metallic conduit used above grade or above slab before the HDPE conduit passes through the grade or slab. HDPE may be run complete without transition only where the conduit terminates in a poured concrete base (such as a pole base).

3.7 GENERAL INSTALLATION – BOXES
A. Refer to the Drawings for the general location of boxes and outlets.
B. Switch boxes near doors:
   1. Install close to trim when located by doors.
   2. Place wall switch outlets at door locations on the lock side of the door. If no usable wall space adjacent to the lock side jamb is available, place switch outlets on the wall against which the door swings and in a location accessible after the door is fully opened.
C. Boxes required by code due to conduit bends are generally not indicated on the Drawings.
D. The Contractor shall familiarize himself with the details of all rooms, spaces, and construction requirements so that the installation of outlets and other electrical equipment shall not interfere with work of other trades or render the outlets or equipment inaccessible for maintenance or repair.
E. Any outlet, box, or related item may be relocated within 10 feet of its indicated location without additional cost to others.
F. General Requirements:
   1. Close unused openings with knock-out closures.
   2. Properly support to prevent movement.
   3. Reduced in size if necessary when indicated to be installed in window mullions or other areas requiring narrower or smaller boxes. Substitutions require the Engineer’s approval.

3.8 INSTALLATION – WALL OUTLET BOXES
A. Offset to reduce sound transmission between rooms.
B. Outlet boxes in smoke control walls (such as egress corridor walls) shall be offset at least 24” from each other where mounted on opposite side of the wall. If smoke control wall outlet boxes are not placed at least 24” apart, then the rear of the box shall be covered with a fire rated pad (such as “Metacaulk Box Guard”) which will expand and seal off the box in the event of a fire, or must be completely covered with a fire rated putty along the top, bottom, and sides of the box.
C. If new switches, receptacles, or similar devices are installed in existing outlet boxes, the following shall be provided:
   1. Existing outlet boxes must be of sufficient size to accommodate new devices.
   2. Existing outlet boxes must be of correct heights to conform with ADA and similar code heights. See subsequent information for correct mounting heights. Existing boxes that do not meet the new mounting height requirements shall not be reused for new devices or shall be moved to the new correct mounting heights.

3.9 INSTALLATION – RECESSED BOXES
A. Install so that device and/or coverplates shall be tight and plumb with wall finish.
B. Box supports are required of all interior switch and receptacle boxes unless excluded by the Engineer.

C. Install with device box supports equal to Caddy “H” series “Quick-mount” for interior use.

D. Boxes installed masonry walls may use the mortar fill or block sides to support the boxes provided the fill or sides are in close contact with the boxes and permanently prevent movement.

E. Ganging boxes:
   1. Gang where possible.
   2. Where interior multiple receptacle, switch, or communication outlets are indicated on the Drawings, boxes to be closely grouped, use Caddy “SGB” series of box brackets.
   3. Do not widely space outlets indicated on the Drawings to be grouped.

F. Covers and rings:
   1. Cover with ½” raised galvanized device covers for exposed conduit work.
   2. Furnish with raised galvanized plaster rings for concealed conduit work.
   3. Provide single gang rings for single device mounts even if box is double gang.

3.10 INSTALLATION – CEILING BOXES

A. Install so that device and/or coverplates shall be tight and plumb with ceiling line or tight to exposed structural mounting.

B. Furnish with raised galvanized plaster rings for concealed box installation in plaster, wood, or gypboard ceilings.

C. Furnish 4” square or octagonal 4” nominal sized boxes for connecting to standard fixtures.

D. Structurally support boxes used for hanging lighting fixtures or other items in accordance with the Drawings and NEC Articles 410.

3.11 INSTALLATION – BOX MOUNTING HEIGHTS

A. Mounting heights of outlets: The height of each outlet shall be in accordance with the Specifications and as directed by Architect for special décor or other architectural features. Heights are given above finished floor to the center of the outlet box unless noted otherwise.

B. Standard Mounting Heights:
   1. Wall switches 48”
   2. Receptacles—General use 15”-18” (*1)
   3. Receptacles—Storage 24”
   4. Receptacles—Cabinet work Above splash
   5. Receptacles—Sinks Above lip of sink
   6. Desk Telephone/Data 15”-18” (*1)
   7. Disconnect Switches 48”-60”
   8. Receptacles in Service areas 24”

(*1) Locate outlet boxes as follows:
   a. Minimum height of receptacles and communication outlets is 15”. This minimum height is for the lowest operable part of the receptacle, and reflects the final height after all floor finishes (such as carpet) have been installed. For vertically mounted duplex wall outlets, this places the center of the box at no less than 16.5” AFF assuming vinyl tile (carpet or thicker floor covering will increase this height).
b. Outlets in close proximity to each other shall be set at the same height to satisfy the most restrictive condition so as to avoid a staggered appearance.

3.13 CLEANING

C. Section 01 70 00 – Contract Closeout: Final cleaning.
D. Clean interior of boxes to remove dust, debris, and other material.
E. Clean exposed surfaces and restore finish.

END OF SECTION – 28 05 33
SECTION 28 31 00 - NEW FIRE ALARM AND DETECTION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install a conventional manual and automatic fire alarm system that is electrically supervised, non coded, NFPA Style 4, low voltage. Voice evacuation is required for Group E occupancy of the project. A complete new system shall be installed at both Heritage Hills Elementary School and Spring Canyon Elementary School.

B. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

C. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

D. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

E. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).

F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

G. The installing company shall employ NICET (minimum Level IV Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

H. Related Sections:
   2. Section 28 05 33 - Conduits and Backboxes for Electronic Safety and Security.

1.2 QUALITY ASSURANCE

A. Contractor must be a firm normally engaged in fire alarm and detection work and shall be factory authorized by the manufacturer of the equipment offered to install and service that particular product line.

B. Contractor shall have a permanently staffed service office within a 60 mile radius of the project site.

C. Installation of the system shall be subject to the approval, inspection, and testing of all authorities having jurisdiction.

D. All components of the system, and their installation, shall conform to the approval requirements of the Underwriters Laboratories and the National Fire Protection Association.
E. Upon completion of the installation of the fire alarm system, the Electrical Contractor shall provide to the Architect a signed written statement equal to the following: “The undersigned, having been engaged as the Electrical Contractor on the Heritage Hills Elementary School and Spring Canyon Elementary School for Canyon Independent School District projects, confirms that the fire alarm equipment was installed in accordance with the Specifications and also in accordance with wiring diagrams, instructions and/or directions provided to us by the manufacturer.”

1.3 SCOPE

A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings. Voice evacuation is required for the new system to be installed at Canyon Junior High School.

B. Basic Performance:
   1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
   2. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.
   3. Notification Appliance Circuits (NAC) shall be wired Class B as part of an addressable device connected by the SLC Circuit.
   4. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
   5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

C. BASIC SYSTEM FUNCTIONAL OPERATION
   1. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
      a. The system alarm LED on the system display shall flash.
      b. A local piezo electric signal in the control panel shall sound.
      c. A backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
      d. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
      e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
      f. Activate UDACT for off premise monitoring.

1.4 SUBMITTALS

A. Section 01 30 00 - Submittals: Submittal procedures.

B. Product Data: Submit catalog data showing electrical characteristics and connection requirements demonstrating compliance with these specifications.

C. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.

D. Manuals:
1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

E. Software Modifications:
1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

F. Certifications:
1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 – Contract Closeout: Closeout procedures.
B. Project Record Documents: Record actual locations of each item of equipment, and show interconnecting wiring.
C. Operation and Maintenance Data: Submit operator instructions for each required mode of operation, routine troubleshooting procedures, and manufacturer's operation and maintenance manual for each item of equipment and accessory.

1.6 WARRANTY:
All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.7 POST CONTRACT MAINTENANCE:
A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled...
maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

C. Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:
   1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.
   2. Each circuit in the fire alarm system shall be tested semiannually.
   3. Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

1.8 POST CONTRACT EXPANSIONS:
A. The contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.
B. As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).
C. The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labor necessary to install this hardware.
D. Do not include cost of conduit or wire or the cost to install conduit or wire except for labor to make final connections at the FACP and at each intelligent addressable device. Do not include the cost of conventional peripherals or the cost of initiating devices or notification appliances connected to the addressable monitor/control modules.
E. Submittals that do not include this estimate of post contract expansion cost will not be accepted.

1.9 STANDARDS AND CODES
A. The fire alarm system, including both equipment and installation, shall comply with the following codes and standards:
   1. NFPA 72.
   2. NEC Article 760.
   3. Applicable UL listings.

PART 2 PRODUCTS
2.1 ACCEPTABLE MANUFACTURERS
A. Manufacturers:
   1. Notifier.
   2. Substitutions: As permitted by the Engineer.
2.2 CONTROL PANEL REQUIREMENTS

A. Main FACP or network node shall be a NOTIFIER Model NFS2-640 and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices. The system shall also contain a voice evacuation panel to permit voice evacuation signals to be broadcast.

B. Operator Control
   1. Acknowledge Switch:
      a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.
      b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
   2. Alarm Silence Switch:
      a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
   3. Alarm Activate (Drill) Switch:
      a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
   4. System Reset Switch:
      a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
   5. Lamp Test:
      a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

C. System Capacity and General Operation
   1. The control panel or each network node shall provide, or be capable of expansion to 636 intelligent/addressable devices.
   2. The control panel or each network node shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 2.0 amps @ 30 VDC.
   3. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.
   4. The Notification Appliance Circuits shall be programmable to Synchronize with System Sensor, Gentex and Wheelock Notification Appliances.
   5. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with
easy touch rubber keys for the field programming and control of the fire alarm system.

6. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.

7. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.

8. The FACP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.

9. The FACP or each network node shall provide the following features:
   a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
   b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
   c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
   d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be .5 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also support sensitive advanced detection laser detectors with an alarm level range of .03 percent per foot to 1.0 percent per foot. The system shall also include up to nine levels of Prealarm, selected by detector, to indicate impending alarms to maintenance personnel.
   e. The ability to display or print system reports.
   f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
   g. PAS presignal, meeting NFPA 72 3-8.3 requirements.
   h. Rapid manual station reporting (under 3 seconds) and shall meet NFPA 72 Chapter 1 requirements for activation of notification circuits within 10 seconds of initiating device activation.
   i. Periodic detector test, conducted automatically by the software.
   j. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
   k. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
   l. Walk test, with a check for two detectors set to same address.
   m. Control-by-time for non-fire operations, with holiday schedules.
   n. Day/night automatic adjustment of detector sensitivity.
   o. Device blink control for sleeping areas.

10. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2:2.2), and California Code. Panel notification circuits (NAC 1,2,3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm
and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3 or 5 minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."

11. Network Communication
   a. The FACP shall be capable of communicating on a Local Area Network (LAN), a firmware package that utilizes a peer-to-peer, inherently regenerative communication format and protocol.

D. Central Microprocessor
   1. The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
   2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
   3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
   4. A special program check function shall be provided to detect common operator errors.
   5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
   6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

E. System Display
   1. The system shall support the following display mode options:
      a. The CPU with no display option shall allow the fire alarm control panel to function as a data-gathering panel when the panel is connected to a network with a Network Control Station (NCS) or Network Control Annunciator (NCA). In this application, the NCS or NCA shall provide all of the necessary controls and indicators to be used by the system operator. Programming of the CPU may be accomplished from the NCS or by use of a laptop PC with the software programming utility connected directly to the CPU.
b. 80 character display option. The display shall include an 80-character backlit alphanumeric Liquid Crystal Display (LCD) and a full PC style QWERTY keypad.

c. 640-character display option. The design of the CPU shall provide for a configuration with the 640 Character display mounted on the front of the CPU in place of the standard 80-character display.

2. The display shall provide all the controls and indicators used by the system operator:
   a. The 80-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.
   b. The 640-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

3. The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.

4. The display shall also provide Light-Emitting Diodes.
   a. The 80-character display shall provide 12 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, ALARM SILENCED, Controls Active, Pre-Discharge, Discharge and Abort.

5. The 640-character display shall provide 11 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY EVENT, SYSTEM TROUBLE, ALARM SILENCED, DISABLED POINTS, OTHER EVENTS, CPU FAILURE and Controls Active.

6. The display shall have QWERTY type keypad.
   a. The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
   b. The 640-character display shall use 10 "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility.

7. The system shall support the display of battery charging current and voltage on the 80-character LCD display.

F. Signaling Line Circuits (SLC)
   1. Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a loop capacity of 318 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

G. Serial Interfaces
1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.
   a. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
   b. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
   c. One EIA-232 interface shall be used to connect a UL-listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
   d. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
   e. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

H. Enclosures:
1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

I. Power Supply:
1. A high tech off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.
2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 55 AH or
may be used with an external battery and charger system. Battery arrangement may be configured in the field.

4. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
   a. Ground Fault LED
   b. AC Power Fail LED
   c. NAC on LED (4)

5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.

6. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 200 AH.

7. All circuits shall be power-limited, per UL864 requirements.

J. Auxiliary Field Power Supply - Addressable

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.

2. The addressable power supply for the fire alarm system shall provide a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.

3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.

4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.

5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.

6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.

7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.
9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.
10. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

K. Field Charging Power Supply (FCPS)
The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.
1. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.
2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
3. The FCPS shall include an attractive surface mount backbox.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.

L. Specific System Operations
1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the
verification cycle. These counters may be displayed and reset by the proper operator commands.

3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.

4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
   a. Device status
   b. Device type
   c. Custom device label
   d. View analog detector values
   e. Device zone assignments
   f. All program parameters

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.

6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.

7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.

9. Software Zones: The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.

10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
   a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
   b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
   c. All devices tested in walk test shall be recorded in the history buffer.

11. Waterflow Operation
An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.

12. Supervisory Operation
An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

13. Signal Silence Operation
The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

14. Non-Alarm Input Operation
Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

15. Combo Zone
A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

2.3 ADDRESSABLE DEVICES - GENERAL

A. Requirements:
1. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute.
3. Addressable devices which require special equipment to address are not an allowable substitute.
4. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
5. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
6. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
7. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
8. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
9. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

11. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

12. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

14. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

2.4 AUXILIARY CONTROL AND MONITORING MODULES:

A. Requirements:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

2. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

4. The Addressable Dry Contact Monitor Module shall be a FMM-1

2.5 MANUAL PULL STATIONS:

A. Manual Fire Alarm Stations

1. Manual fire alarm stations shall be non-code, non-breakglass type, equipped with key lock so that they may be tested without operating the handle.

2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.

3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet (30.5 m) front or side.

4. Manual stations shall be constructed of high impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one half inch (12.7 mm) in size or larger.

5. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
6. The Addressable Manual Fire Alarm Box shall be a NBG-12IX

2.6 CONVENTIONAL PHOTOELECTRIC AREA SMOKE DETECTORS:

A. Requirements:
1. Photoelectric smoke detectors shall be a 24 VDC, two wire, ceiling-mounted, light scattering type using an LED light source.
2. Each detector shall contain a remote LED output and a built-in test switch.
3. Detector shall be provided on a twist-lock base.
4. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall flash at least every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not go into alarm when exposed to air velocities of up to 3000 feet (914.4 m) per minute.
7. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
8. All field wire connections shall be made to the base through the use of a clamping plate and screw.
9. The Intelligent Photoelectric Smoke Detector shall be a FSP-851

2.7 CONVENTIONAL IONIZATION TYPE AREA SMOKE DETECTORS:

A. Requirements:
1. Ionization type smoke detectors shall be a two wire, 24 VDC type using a dual unipolar chamber.
2. Each detector shall contain a remote LED output and a built-in test switch.
3. Detector shall be provided on a twist-lock base.
4. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs) over 360 degrees, on the detector, which may be seen from ground level. This LED shall flash every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not alarm when exposed to air velocities of up to 1,200 feet (365.76 m) per minute. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
7. All field wire connections shall be made to the base through the use of a clamping plate and screw.
8. The Intelligent Ionization Smoke Detector shall be a FSI-851

2.8 AUTOMATIC CONVENTIONAL HEAT DETECTORS:

A. Requirements:
1. Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit (57.2 Celsius) for areas where ambient temperatures do not exceed 100 degrees (37.7 Celsius), and 200 degrees (93.33 Celsius) for areas where the temperature does not exceed 150 degrees (65.5 Celsius).
2. Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic heat detectors shall have a smooth ceiling rating of 2500 square feet (762 square meters).
6. The Intelligent Thermal Detectors shall be a FST-851

2.9 WATERFLOW INDICATOR:
A. Requirements:
1. Waterflow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.
3. All waterflow switches shall come from a single manufacturer and series.
4. Waterflow switches shall be provided and connected under this section but installed by the mechanical contractor.
5. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

2.10 SPRINKLER AND STANDPIPE VALVE SUPERVISORY SWITCHES:
A. Requirements:
1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.
   a. This unit shall provide for each zone: alarm indications, using a red alarm an yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also
have an ON-LINE LED, local piezo electric signal, local acknowledge/lamp test switch, and custom slide-in zone/function identification labels.

b. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, telephone zone select, speaker select, global signal silence, and global system reset within the confines of all applicable standards.

2.11 TWO WIRE DETECTOR MONITOR MODULE:

A. Requirements:
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. The Two Wire Detector Monitor Module shall be a FZM-1.

2.12 ADDRESSABLE CONTROL MODULE:

A. Requirements:
1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
4. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.
5. The Addressable Control Module shall be a FCM-1.

2.13 ADDRESSABLE RELAY MODULE:

A. Requirements:
1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
2. The Addressable Relay Module shall be a FRM-1.

2.14 ISOLATOR MODULE:

A. Requirements:
1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

5. The Isolator Module shall be an ISO-X.

2.15 EXTERIOR HORN:
A. Requirements:
   1. Minimum 90 dB horn output.
   2. Weatherproof box, surface mounted.
   3. Grille cover front.
   4. Fire red enamel finish.

B. Equal to Notifier MBG-FR/WPBB.

2.16 ALPHANUMERIC LCD TYPE ANNUNCIATOR:
A. Requirements:
   1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
   2. The LCD annunciator shall display all alarm and trouble conditions in the system.
   3. An audible indication of alarm shall be integral to the alphanumeric display.
   4. The display shall be UL listed for fire alarm application.
   5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
   6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
   7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a keyswitch or password.
   8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

2.17 UNIVERSAL DIGITAL ALARM COMMUNICATOR TRANSMITTER (UDACT):
The UDACT is an interface for communicating digital information between a fire alarm control panel and an UL-Listed central station.

   1. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.
2. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to three different telephone numbers.

3. The UDACT shall be completely field programmable from a built-in keypad and 4 character red, seven segment display.

4. The UDACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.

5. Communication shall include vital system status such as:
   - Independent Zone (Alarm, trouble, non-alarm, supervisory)
   - Independent Addressable Device Status
   - AC (Mains) Power Loss
   - Low Battery and Earth Fault
   - System Off Normal
   - 12 and 24 Hour Test Signal
   - Abnormal Test Signal (per UL requirements)
   - EIA-485 Communications Failure
   - Phone Line Failure

6. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 2,040 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.

2.18 BATTERIES:

A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

C. If necessary to meet standby requirements, external battery and charger systems may be used.

2.19 CONDUIT AND WIRE:

A. Conduit:
   1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
   2. All wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
   3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-55.
   4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

6. Conduit shall be 3/4-inch (19.1 mm) minimum.

B. Wire:
1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
6. All field wiring shall be electrically supervised for open circuit and ground fault.
7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems that do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

C. Terminal Boxes, Junction Boxes and Cabinets:
All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
1. Installation shall comply with Article 760 of the National Electric Code and NFPA 72.
2. All wiring shall be installed in conduit.
3. Coordinate locations of all ceiling mounted devices with other trades, including ceiling and HVAC installations. Contact Engineer for resolution if the indicated location of ceiling devices conflicts with work of other trades.
4. Connect all initiation and annunciation wiring so that the conductors are broken at the device and not wrapped around a termination screw.
5. Smoke detector installation sequence:
   a. No smoke detector head shall be installed until adverse construction conditions, such as dust, dirt, fumes, and related potential nuisance alarm sources, are removed.
   b. This provision does not prohibit the installation of the detector bases, wiring, or ancillary items that are not affected by contaminates.
   c. This provision is waived only if the authority having jurisdiction requires the operation of the detectors during construction. If installed and activated when construction contaminates are present, the Contractor shall retest 100% of the devices to ensure that all are operating within correct parameters. Replace devices, without cost to the Owner, that are found to be outside the listed and marked sensitivity range.

B. Control panel power circuit:
   1. Feed fire alarm control panel with a dedicated 120V branch circuit “primary source” composed of a hot, neutral, and ground conductor. Minimum conductor size is #12AWG.
   2. Connect primary source feed to a dedicated 20A 1 pole circuit breaker in the panelboard noted on the Drawings or determined by the Engineer.
   3. Label circuit breaker on panel directory as “FIRE ALARM CIRCUIT CONTROL” as required by NFPA 72.

C. Annunciation and initiation circuits:
   1. Fire alarm installer is responsible for determining the appropriate sizes of conductors to limit voltage drop, during alarm and initiation, to a maximum of 5% of the nominal voltage of circuits.
   2. See Part 2 above for minimum conductor sizes.

D. Fire alarm control panel:
   1. Install the control panel surface mounted in the location as indicated on the Drawings.
   2. Install the back-up batteries and connect to the battery charger. Battery shall be appropriately sized per NFPA with sizing calculations provided with the fire alarm submittal.
   3. Install output relays for control of any equipment or connection to other equipment as necessary.
   4. Connect all initiation and annunciation circuits. Test all circuits for continuity and operation.
   5. Provide all programming, detector and pull station addressing, alarm sequencing, and similar work required for service.
   6. Adjust sensitivity of all smoke and heat detector sensitivity to required levels. Replace any detectors that do not meet required levels.
   7. Password protect the software and hardware against unauthorized changes.
   8. Tie to remote annunciator.

E. Initiation devices:
   1. Install manual pull stations in the locations indicated on the Drawings.
   2. Connect to each fire sprinkler flow and tamper switches as follows:
      a. Switches shall be furnished with the fire sprinkler control valves.
      b. Manual closing a tamper switch shall provide a trouble signal to the control panel.
c. Water flow closing of a flow switch shall provide an alarm signal to the control panel. Water flow switch activation of the control panel may be time delayed in accordance with NFPA requirements (maximum of 90 second delay with flow equal to one sprinkler head) to prevent nuisance tripping from water hammer, surges, or variable pressure problems in the fire sprinkler system.

3.2 OPERATION

A. The operation of any corridor, common area, closet, or similarly located automatic or manual alarm initiating device, including but not limited to smoke detectors, duct detectors, or pull stations, shall initiate the following:
   1. Put fire alarm control panel into alarm condition and sound audible/visual signals until it is manually silenced. This alarm shall annunciate speaker/strobe and strobe units in the wing or administrative area in which the detector is located, or if so selected by the Owner, a general alarm for the entire facility.
   2. Indicate alarm origin by device location designation on the fire alarm control panel display.
   3. Close all fire and smoke dampers, or, if so directed, on those dampers associated with the sensed area of smoke.
   4. Notify security control system for any release of security doors or locks held closed by electrical means.

B. Fire alarm system shall include voice evacuation as the means of system notification.

3.3 TESTING AND DEMONSTRATION

A. Testing of new equipment:
   1. Manual Testing:
      a. Field test all smoke detectors in the entire system to initiate an alarm. Utilize canned smoke, aerosol, Gemini smoke generator, or other approved device or equipment that simulates smoke particles and is acceptable for testing the installed equipment.
      b. Replace all devices that operate outside of approved range.
      c. All alarm and initiation circuits shall test free of ground.
   2. Completion certificate:
      a. After testing is completed and all defective equipment replaced, provide and complete a certificate posted at or near the main control panel.
      b. Certificate shall identify the standards applicable and certification of compliance with the applicable standards. If approved variances are allowed, document these variations with the certificate.
      c. Contractor shall retain one copy for his records, forward one copy to the authority having jurisdiction, and one copy to the State Fire Marshall’s office.

3.4 DOCUMENTATION AND SPARE PARTS

A. Provide all documentation including:
   1. For Owner:
      a. At least on operation and parts manual delivered to Owner. O&M manual shall include listing of parts and components by description and part number.
b. Provide a record for all software and hardware version numbers at the fire alarm control panel.
c. Complete a copy of the “Record of Completion” found in NFPA 72 and deliver to the Owner.
d. Provide a recommended list of preventative maintenance and suggested intervals for future testing of equipment.

2. For Architect or Engineer:
a. Record drawings showing the location of all devices.

3. For State of Texas:
a. Complete and forward to the State of Texas Office of the State Fire Marshall a copy of the “Certificate of Installation” form.

B. Provide the Owner a minimum of 6 keys for resetting manual pull stations.

C. Demonstration:
1. Provide Owner training in the operation and capabilities of the entire fire alarm system at the conclusion of the project.
2. Training shall be on the Owner’s premises at mutually agreed dates and times. Notify the Owner at least 5 working days prior to the demonstration.
3. Training shall be for a period of not less than 4 continuous hours, or additional time, not to exceed 4 additional hours, if so required by the Owner.
4. Inadequate or incomplete training shall be repeated at the Contractor’s expense.

END OF SECTION – 28 31 00
SECTION 31 23 00 - EXCAVATION AND EMBANKMENT

PART 1: GENERAL

1.1 This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct streets and parking areas as well as other areas for drainage, sidewalks or other purposes in accordance with these specifications and in conformity to the dimensions and typical section shown on the plans. Building pad construction is not a part of this section of specifications. When this specification conflicts with the Geotechnical Soils Investigation, the recommendations in the Geotechnical soils investigation shall followed in place of these specifications. A copy of the Geotechnical Soils Investigation, if not available with the official bid documents, will be made available upon request. Additionally, where plan sheets conflict with specifications, the plans sheets shall be used in place of specifications.

1.2 CLASSIFICATION. All material excavated shall be classified as defined below:

(a) Unclassified Excavation. Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature.

1.3 UNSUITABLE EXCAVATION. Any material containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction.

PART 2: EXECUTION

2.1 GENERAL. All unsuitable material shall be disposed of off-site.

If necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. The Contractor shall, at his own expense, satisfactorily repair or pay the cost of all damage to such facilities or structures, which may result from any of the Contractor’s operations during the period of the contract.

2.2 EXCAVATION. No excavation shall be started until the Contractor has staked out the work. All suitable excavated material shall be used in the formation of embankment, subgrade, or for other purposes shown on the plans. All unsuitable material shall be disposed of off-site.

When the volume of the excavation exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development or disposed of as directed. When the volume of excavation is not sufficient for constructing the fill to the grades indicated, the deficiency shall be obtained from approved sources.

The grade shall be maintained so that the surface is well drained at all times. When necessary, temporary drains and drainage ditches shall be installed to intercept or divert surface water, which may affect the work.

(a) Removal of Utilities. The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by someone other than the Contractor, e.g., the utility unless otherwise shown on the plans. All existing foundations shall be excavated for at least 2 feet below the top of subgrade or as indicated on the plans, and
the material disposed of as directed. All foundations thus excavated shall be backfilled with suitable material and compacted as specified herein.

(b) **Compaction Requirements.** The subgrade under areas to be paved shall be compacted to a depth as shown on the plans and made sure to comply with the geotechnical soils investigation. Compaction shall be to a density of not less than 95 percent for cohesive soils or 100 percent for noncohesive soils of the maximum density as determined by ASTM D 698. One dry density and moisture content test per 300 hundred (300) square yards.

The in-place field density shall be determined in accordance with ASTM D1556, ASTM D 2167 or ASTM 2922. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in top 6 inches of the subgrade. The finished grading operations, conforming to the typical cross section, shall be completed and maintained at least 1,000 feet ahead of the paving operations or as directed by the Engineer.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross section, and alignment shown on the plans or as directed by the Engineer.

2.3 **DRAINAGE EXCAVATION.** Drainage excavation shall consist of excavating for drainage ditches such as intercepting, inlet or outlet, for temporary levee construction; or for any other type as designed or as shown on the plans. The work shall be performed in the proper sequence with the other construction. All satisfactory material shall be placed in fills; unsuitable material shall be placed in waste areas or as directed. Intercepting ditches shall be constructed prior to starting adjacent excavation operations. All necessary work shall be performed to secure a finish true to line, elevation, and cross section.

The Contractor shall maintain ditches constructed on the project to the required cross section and shall keep them free of debris or obstructions until the project is accepted.

2.4 **PREPARATION OF EMBANKMENT AREA.** Where an embankment is to be constructed to a height of 4 feet or less, all sod and vegetable matter shall be removed from the surface upon which the embankment is to be placed, and the cleared surface shall be completely broken up by plowing or scarifying to a minimum depth of 6 inches. This area shall then be compacted as indicated in paragraph 2.5.

2.5 **FORMATION OF EMBANKMENTS.** Embankments shall be formed in successive horizontal layers of not more than 8 inches in loose depth for the full width of the cross section, unless otherwise approved by the Engineer.

The grading operations shall be conducted, and the various soil strata shall be placed, to produce a soil structure as shown on the typical cross section or as directed. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Operations on earthwork shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing, or other unsatisfactory conditions of the field. The Contractor shall drag, blade, or slope the embankment to provide proper surface drainage.

The material in the layer shall be within +/-2 percent of optimum moisture content before rolling to obtain the prescribed compaction. In order to achieve a uniform moisture content throughout the layer, wetting or drying of the material and manipulation shall be required when necessary.
Should the material be too wet to permit proper compaction or rolling, all work on all of the af-
fected portions of the embankment shall be delayed until the material has dried to the required
moisture content. Sprinkling of dry material to obtain the proper moisture content shall be done
with approved equipment that will sufficiently distribute the water. Sufficient equipment to fur-
nish the required water shall be available at all times.

Rolling operations shall be continued until the embankment is compacted to not less that 95 per-
cent of maximum density for noncohesive and cohesive soils as determined by ASTM D 698.
Under all areas to be paved, the embankments shall be compacted to a depth of 6 inches and to a
density of not less that 95 percent of the maximum density as determined by ASTM D 698. One
dry density and moisture content test per three hundred (300) square yards.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches.

The in-place field density shall be determined in accordance with ASTM D 1556, ASTM D 2167
or ASTM D 2922.

Compaction areas shall be kept separate, and no layer shall be covered by another until the proper
density is obtained.

During construction of the embankment, the Contractor shall route equipment at all times, both
when loaded and when empty, over the layers as they are placed and shall distribute the travel
evenly over the entire width of the embankment. The equipment shall be operated in such a man-
ner that hardpan, cemented gravel, clay, or other chunky soil material will be broken up into
small particles and become incorporated with the other material in the layer.

In the construction of embankments, layer placement shall begin in the deepest portion of the fill;
as placement progresses, layers shall be constructed approximately parallel to the finished pave-
ment grade line.

When rock and other embankment material are excavated at approximately the same time, the
rock shall be incorporated into the outer portion of the embankment and the other material shall
be incorporated under the future paved areas. Stones or fragmentary rock larger than 4 inches in
their greatest dimensions will be not be allowed in the top 6 inches of the subgrade. Rockfill
shall be brought up in layers as specified or as directed and every effort shall be exerted to fill the
vooids with the finer material forming a dense, compact mass. Rock or boulders shall not be dis-
posed of outside the excavation or embankment areas, except at places and in the manner desig-
nated.

When the excavated material consists predominantly of rock fragments of such size that the mate-
rial cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further
breaking down the pieces, such material may be placed in the embankment as directed in layers
not exceeding 2 feet in thickness. Each layer shall be leveled and smoothed with suitable leveling
equipment and by distribution of spalls and finer fragments of rock. These type lifts shall not be con-
structed above an elevation 4 feet below the finished subgrade. Density requirements will not
apply to portions of embankments constructed of materials, which cannot be tested in accordance
with specified methods.

Frozen material shall not be placed in the embankment nor shall embankment be placed upon fro-
zen material.
2.6 **FINISHING AND PROTECTION OF SUBGRADE.** After the subgrade has been substantially completed the full width shall be conditioned by removing any soft or other unstable material which will not compact properly. The resulting areas and all other low areas, holes or depressions shall be brought to grade with suitable select material. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans.

Grading of the subgrade shall be performed so that it will drain readily. The Contractor shall take all precautions necessary to protect the subgrade from damage and shall limit hauling over the finished subgrade to that which is essential for construction purposes.

All ruts or rough places that develop in a completed subgrade shall be smoothed and recompacted.

2.7 **HAUL.** All hauling will be considered a necessary and incidental part of the work. Its cost shall be considered by the Contractor and included in the contract price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

2.8 **TOLERANCES.** In those areas upon which a base course is to be placed, the top of the subgrade shall be of such smoothness that, when tested with a 16-foot straightedge applied parallel and at right angles to the centerline, it shall not show any deviation in excess of ½ inch, or shall not be more than 0.04 foot from true grade as established by grade hubs or pins. Any deviation in excess of these amounts shall be corrected by loosening, adding, or removing materials; reshaping; and recompacting by sprinkling and rolling.

On shoulder areas, intermediate and other designated areas, the surface shall be of such smoothness that it will not vary more than 0.10 foot from true grade as established by grade hubs. Loosening, adding or removing materials, and reshaping shall correct any deviation in excess of this amount.

**END OF SECTION 31 23 00**
SECTION 31 31 16

SOIL TREATMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Treatment of building subgrade for termites.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data and application instructions for termite treatment chemicals.
   1. Contractor shall maintain material data safety sheets on project site for duration of subsoil treatment in accordance with applicable laws and ordinances.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:
   1. Submit evidence that applicator of termite control chemicals is licensed by the Structural Pest Control Board of Texas.
   2. Submit certificate of complete liability and property damage insurance from applicator with minimum limit of $1,000,000.
   3. Submit minimum three references for pest control performed by applicator within previous three years.

1.4 EXISTING CONDITIONS

A. Notify Architect immediately of existing job conditions that affect application of pest control materials required under this Section, or conditions that affect or alter scope of work of this Section, including unforeseen conditions.

1.5 QUALITY ASSURANCE

A. Applicator of pest control chemicals shall be licensed by the Structural Pest Control Board of Texas to handle proposed chemicals, and shall have minimum five years commercial experience applying termite treatment chemicals.

B. Contractor and applicator shall both attend Pre-Construction Conference. At that time, tour of existing site will be conducted, and sequencing of application will be discussed.

1.6 WARRANTY

A. Upon completion of Work, and as condition for final acceptance of Work, provide to Owner with written guarantee stating following and jointly signed by both applicator and Contractor:
   1. Soil treatment was made with not less than specified concentration rates, with materials and methods specified.
   2. Effectiveness of treatment is guaranteed for period of one year from date of application to prevent infestation of subterranean termites.
3. Contractor has right during warranty period to make period examination of property.
4. Owner will have right to renew warranty on annual basis.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Substitutions: Comply with Section 01 25 00.

2.2 MATERIALS
A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by
   one of the following:
   1. Bayer Environmental Science
   2. FMC Corporation
   3. Syngenta Professional Products.
B. Termiticide: Provide an EPA-registered termiticide complying with requirements of
   authorities having jurisdiction in a soluble or emulsible, concentrated formulation that dilutes
   with water or foaming agent, and formulated to prevent termite infestation. Use only soil
   treatment solutions that are not harmful to plants. Provide quantity required for application
   at the label volume and rate for the maximum termiticide concentration allowed for each
   specific use, according to the product’s EPA-Registered Label.

PART 3 EXECUTION

3.1 PREPARATION
A. Surface Preparation:
   1. Remove foreign matter that could decrease treatment effectiveness on areas to be treated.
   2. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs
      and foundations.

3.2 APPLICATION
A. Application Rates: Apply chemicals in rates listed below unless instructions on product label
   require greater rates or are restricted by governmental regulations.
   1. Under slabs on grade structures, treat soil before concrete slabs are placed, using the
      following application rates:
      a. Apply 4 gallons of chemical solution per 10 linear feet to soil in critical areas under
         slabs, including entire inside perimeter of foundation walls, along both sides of
         interior partition walls, around plumbing pipes and electrical conduit penetrating slab,
         around interior column footers and along expansion and control joints.
      b. Apply 1 gallon of chemical solution per 10 sq. ft. as an overall treatment under slab
         and attached slab areas where fill material is soil or unwashed gravel.
      c. Apply 1-1/2 gallons of chemical solution per 10 sq. ft. as an overall treatment under
         slab and attached slab areas where fill material is washed gravel or other coarse non-
         absorbent washed material.
d. Dig a trench 6 to 8 inches wide along outside of foundation wall to a depth of not less than 12 inches with punched holes to top of footing at not more than 12 inches o.c. and apply 4 gallons of chemical solution per 10 linear feet of trench for each foot of depth from grade to top of footing. Mix chemical solution with soil as it is being replaced in trench.

2. At grade beams, treat voids at rate of 2 gallons per 10 linear feet, poured directly into hollow spaces.

3.3 CLEANING

A. After completion of chemical application, remove debris and spillage.

3.4 ADJUSTING

A. If subterranean termite activity is discovered during warranty period, re-apply soil treatment with acceptable remedial techniques, and repair or replace damage caused by termite infestation up to limit of $100,000/occurrence, with no aggregate limit on claims during warranty period.

END OF SECTION
SECTION 32 11 00 - PLANT MIX BITUMINOUS PAVEMENTS

PART 1: DESCRIPTION

1.1 This item shall consist of a surface course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross sections shown on the plans. Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course. The courses shall be constructed in lifts not to exceed 2 inches in compacted thickness. When this specification conflicts with the Geotechnical Soils Investigation, the recommendations in the Geotechnical soils investigation shall followed in place of these specifications. A copy of the Geotechnical Soils Investigation can be obtained from the Architect. Additionally, where plan sheets conflict with specifications, the plans sheets shall be used in place of specifications.

PART 2: MATERIALS

2.1 AGGREGATE. Aggregates shall consist of crushed stone or crushed gravel with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 10 sieve shall be known as coarse aggregate, the portion passing the No. 10 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler.

(a) Coarse Aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating with the bituminous material. The percentage of wear shall not be greater than 40 percent when tested in accordance with ASTM C 131. The magnesium sulfate soundness loss shall not exceed 30 percent, after five cycles, when tested in accordance with ASTM C 88.

Aggregate shall contain at least 85 percent by weight of crushed pieces having two or more fractured faces. Fractured faces shall be obtained by artificial crushing.

The aggregate shall not contain more than 8 percent, by weight, of flat or elongated pieces, a flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

(b) Fine Aggregate. Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The fine aggregate, including any blended filler, shall have a plasticity index of not more than six and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

Natural sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

(c) Sampling and Testing. ASTM D 75 shall be used in sampling coarse and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. The Contractor shall furnish documentation to the Engineer confirming that the aggregates meet specification requirements.

(d) Sources of Aggregates. Sources of aggregates shall be selected well in advance of the time the materials are required in the work. When the aggregates are obtained from a previously approved source or an existing source producing aggregates that has a satisfactory service record in bituminous pavement construction for at least 5 years, samples shall be submitted 14 days prior to start of production. The Engineer will make an inspection of the producer’s operation. When new sources are to be developed, the Contractor shall indicate the sources and shall submit a plan for
operation 30 days in advance of starting production. Samples from test pits, borings, and other excavations shall be submitted at the same time. Approval of the source of aggregate does not relieve the Contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

(e) **Samples of Aggregates.** The Contractor at the start of production and at intervals shall furnish samples of aggregates during production of bituminous mixtures. The Engineer will designate the sampling points and intervals. The samples will be the basis of approval of specific lots of aggregates from the standpoint of the quality requirements of this section.

2.2 **FILLER.** If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242.

2.3 **BITUMINOUS MATERIAL.** Bituminous material shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Type and Grade, Asphalt Cement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration Grade 85-100</td>
<td>ASTM D 946</td>
</tr>
<tr>
<td>Viscosity Grade AC-10</td>
<td>ASTM D 3381</td>
</tr>
</tbody>
</table>

The Contractor shall furnish vendor’s certified test reports for each tank load of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor’s certified test report for the bituminous material shall be the basis for final acceptance.

**PART 3: COMPOSITION**

3.1 **COMPOSITION OF MIXTURE.** The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

3.2 **JOB MIX FORMULA.** No bituminous mixture for payment shall be produced until the Engineer has approved a job mix formula. The formula shall be submitted in writing by the Contractor to the Engineer at least 14 days prior to the start of paving operations and shall indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. All test data used to develop the job mix formula shall also be submitted. The job mix formula for each mixture shall be in effect until modified in writing by the Engineer. Should a change in sources of materials be made, a new job mix formula must be established before the new material is used.

The bituminous mixture shall be designed using procedures contained in Chapter III, MARSHALL METHOD OF MIX DESIGN, of the Asphalt Institute’s Manual Series No. 2 (MS-2), current edition, and shall meet the requirements of Tables 1 and 2.

**TABLE 1. MARSHAL DESIGN CRITERIA**

<table>
<thead>
<tr>
<th>TEST PROPERTY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Blows</td>
<td>50</td>
</tr>
<tr>
<td>Stability, Minimum pounds</td>
<td>1300</td>
</tr>
<tr>
<td>Flow, 0.01 in.</td>
<td>10-18</td>
</tr>
<tr>
<td>Percent air voids</td>
<td>3.0-5.0</td>
</tr>
</tbody>
</table>
The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM Standard C 136 and C 117. The percentage by weight for the bituminous material shall be within the limits specified.

The gradations in Table 2 represent the limits, which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 2 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

**TABLE 2. AGGREGATE – BITUMINOUS PAVEMENTS**

<table>
<thead>
<tr>
<th>Type “D” (Fine Graded Surface Course):</th>
<th>Percent Aggregate by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1/2” sieve</td>
<td>100</td>
</tr>
<tr>
<td>Passing 3/8” sieve</td>
<td>85 to 100</td>
</tr>
<tr>
<td>Passing No. 4 sieve</td>
<td>50 to 70</td>
</tr>
<tr>
<td>Passing No. 10 sieve</td>
<td>32 to 42</td>
</tr>
<tr>
<td>Passing No. 40 sieve</td>
<td>11 to 26</td>
</tr>
<tr>
<td>Passing No. 80 sieve</td>
<td>4 to 14</td>
</tr>
<tr>
<td>Passing No. 200 sieve</td>
<td>1 to 6</td>
</tr>
<tr>
<td>VMA (% minimum)</td>
<td>14</td>
</tr>
</tbody>
</table>

The job mix tolerances shown in Table 3 shall be applied to the job mix formula to establish a job control grading band. The full tolerances shown in Table 2 still apply if application of the job mix tolerances results in a job control grading band outside the master-grading band.

**TABLE 3. JOB MIX FORMULA TOLERANCES**

<table>
<thead>
<tr>
<th>Material</th>
<th>Tolerance – plus or minus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate passing No. 4 sieve or larger</td>
<td>7 percent</td>
</tr>
<tr>
<td>Aggregate passing No. 10 sieve</td>
<td>6 percent</td>
</tr>
<tr>
<td>Aggregate passing No. 40 sieve</td>
<td>5 percent</td>
</tr>
<tr>
<td>Aggregate passing Nos. 80 and 200 sieves</td>
<td>3 percent</td>
</tr>
<tr>
<td>Bitumen</td>
<td>0.25 percent</td>
</tr>
<tr>
<td>Temperature of mix</td>
<td>20 F</td>
</tr>
</tbody>
</table>

The aggregate gradation may be adjusted within the limits of Table 2 as directed, without adjustments in the contract unit prices.

Deviation from the final approved design for bitumen content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extraction. Extraction tests for bitumen content and aggregate gradation will be made at least once daily. The mixture will be tested for bitumen content in accordance with ASTM D 2172 and for aggregate gradation in accordance with AASHTO T 30.

The completed mixture shall be sampled at the plant to retain job control. One sample shall be taken from each sublot on a random basis, in accordance with procedures contained in ASTM D 3665. A lot shall consist of 1000 tons or each day’s production and shall be divided into 4 sublots. Testing shall be in accordance with the Marshall Method procedures contained in Chapter III of the Asphalt Institute Manual Series No. 2 (MS-2), current edition. If any two consecutive Marshall tests results of any property do not conform
to the requirements shown in Tables 1 and 2, the Contractor shall take immediate corrective action. In no instance shall the percent air voids exceed +/- 1 percent of the job mix formula value.

The Engineer may halt production if the Marshall test criteria are not met and not allow it to resume until the problem is corrected.

If the index of retained strength of the specimens of composite mixture, as determined by ASTM D 1075, is less than 75, the aggregates shall be rejected or the asphalt shall be treated with an antistripping agent. The amount of antistripping agent added to the asphalt shall be sufficient to produce an index of retained strength of not less than 75.

3.3 TEST SECTION. Prior to full production, the Contractor shall prepare a quantity of bituminous mixture according to the job mix formula. The amount of mixture should be sufficient to construct a test section 50 feet long and 20 feet wide placed in two sections and shall be of the same depth specified for the construction of the course that it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

If the test section should proved to be unsatisfactory, the necessary adjustments to the mix design plant operations, and/or rolling procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When test sections do not conform to specification requirements, the pavement shall be removed and replaced at the Contractor’s expense. A marginal quality test section also does not meet specification requirements both sections shall be removed at the Contractor’s expense. Full production shall not begin without the Engineer’s approval. Test sections will be paid for in accordance with paragraph 4.12.

3.4 TESTING LABORATORY. The testing laboratory used to develop the job mix formula and to perform the tests required by this specification shall meet the requirements of ASTM D 3666. A certification that the laboratory meets these requirements shall be submitted to the Engineer.

PART 4: CONSTRUCTION METHODS

4.1 WEATHER LIMITATIONS. The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived, but only at the discretion of the Engineer.

<table>
<thead>
<tr>
<th>Mat Thickness</th>
<th>Base Temperature (Minimum), Deg. F</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 in. or greater</td>
<td>40</td>
</tr>
<tr>
<td>Greater than 1 in. but less than 3 in.</td>
<td>45</td>
</tr>
<tr>
<td>1 in. or less</td>
<td>50</td>
</tr>
</tbody>
</table>

4.2 BITUMINOUS MIXING PLANT. Plants used for the preparation of bituminous mixtures shall conform to the requirements of ASTM D 995 with the following changes:

(a) Requirements for All Plants.
(1) **Truck Sales.** The bituminous mixture shall be weighted on approved scales furnished by the Contractor, or on public scales at the Contractor’s expense. Such scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy.

(2) **Inspection of Plant.** The Engineer, or his/her authorized representative, shall have access, at all times, to all parts of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.

(3) **Storage Bins and Surge Bins.** Paragraph 3.9 of ASTM D 995 is deleted. Instead, the following applies. Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:

The bituminous mixture may be stored in surge bins for period of time not to exceed 3 hours.

The bituminous mixture may be stored in insulated storage bins for a period of time not to exceed 24 hours, provided an inert gas atmosphere is maintained in the bin during the storage period.

The bins shall be such that mix drawn from them meets the same requirements as mix located into trucks.

If the Engineer determines that there is an excessive amount of heat loss, segregation or oxidation of the mixture due to temporary storage, no overnight storage will be allowed.

4.3 **HAULING EQUIPMENT.** Trucks used for hauling bituminous mixtures shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

4.4 **BITUMINOUS PAVERS.** Bituminous pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and shall be capable spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.

The controls shall be capable of working in conjunction with any of the following attachments:

(a) Ski-type device of not less than 30 feet in length or as directed by the Engineer.
(b) Taut string line (wire) set to grade.

(c) Short ski or shoe.

4.5 ROLLERS. Rollers of the vibratory steel wheel, or pneumatic-tired type may be used. They shall be in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of the rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition.

The use of equipment which causes excessive crushing of the aggregate will not be permitted.

4.6 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be heated in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles but shall not exceed 325°F.

4.7 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated to the temperature designated by the job formula within the job tolerance specified. The maximum temperature and rate of heating shall be such that no permanent damage occurs to the aggregates. Particular care shall be taken that overheating does not damage aggregates high in calcium or magnesium content.

The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

4.8 PREPARATION OF BITUMINOUS MIXTURE. The aggregates and the bituminous material shall be weighed and metered and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until the aggregate obtains a uniform coating of bitumen and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce satisfactory mixture. It shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, and approved by the Engineer for each individual plant and for each type of aggregate used. The minimum mixing time shall be 25 seconds. The mixing time will be set to achieve 95 percent of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of the mix shall not exceed 1.0 percent.

4.9 TRANSPORTING, SPREADING, AND FINISHING. The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Section 4.3. Deliveries shall be scheduled so that spreading and rolling of all mixture prepared for one day’s run can be completed during daylight, unless adequate artificial lighting is provided. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

Immediately before placing the bituminous mixture, the underlying course shall be cleared of all debris with power blowers, power brooms, or hand brooms as directed.

The mix shall be placed at a temperature of not less than 250°F when asphalt cement is used.

Upon arrival, the mixture shall be spread to the full width by an approved bituminous paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope.

The mixture shall be placed in consecutive adjacent strips having a minimum width of 12.0 feet except where edge lanes require less width to complete the area. The longitudinal joint in one layer shall offset
that in the layer immediately below by at least 1 foot; however, the joint in the top layer shall be offset by at least 2 feet from transverse joints in the previous layer. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools.

4.10 **COMPACTION OF MIXTURE.** After spreading, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be rolled when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor.

The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section, and the required field density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers.

Any mixture that becomes loose and broken, mixed with dirt, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor’s expense. Skin patching shall not be allowed.

4.11 **JOINTS.** The formation of all joints shall be made in such matter as to ensure a continuous bond between old and new sections of the course. All joints shall have the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint.

4.12 **ACCEPTANCE SAMPLING AND TESTING OF BITUMINOUS MIXTURE (DENSITY).** Pavement density will be determined by comparing the density of cores taken from the compacted pavement to the density of laboratory-compacted specimens.

(a) **Lot Sizes.** The pavement will be accepted for density on a lot basis. A lot will consist of:

(1) One day’s production where it is not expected to exceed 2,000 tons.

(2) A half-day’s production where a day’s production is expected to consist of between 2,000 and 4,000 tons.

(3) Similar subdivisions for quantities greater than 4,000 tons.
(b) **Laboratory Density.** Bituminous mixture for laboratory-compacted specimens shall be sampled on a lot basis from trucks delivering material to the job site. The lot size shall be the same as indicated in paragraph 4.12a. One sample shall be taken from each lot on a random basis, in accordance with procedures contained in ASTM D 3665. One laboratory compacted specimen shall be prepared from each lot.

The specimens shall be compacted in accordance with ASTM D 1559, Section 3.5. The sample of bituminous mixture may be put in a covered metal tin and placed in an oven for not more than 30 minutes to maintain the heat. In no instance shall the mixture cool more than 20°F below the job-mix temperature prior to compaction. The density of each specimen shall be determined in accordance with ASTM D 2726 or D 1188, whichever is applicable.

(c) **Core Density.** Cores for determining the density of the compacted pavement shall be taken on a lot basis. The lot size shall be the same as indicated in paragraph 4.12a and shall be divided into four equal sublots. One core shall be taken from each subplot on a random basis in accordance with procedures contained in ASTM C 3665. The cores shall be taken in accordance with the requirements of paragraph 4.13. The density of each core shall be determined in accordance with ASTM D 2726 or D 1188, whichever is applicable.

(d) **Pavement Density.** The pavement density shall be determined by dividing the core density of each subplot by the average density of the laboratory-prepared specimens.

(e) **Acceptance Criteria.** Each lot of compacted pavement will be accepted with respect to density, when the average field density is equal to or greater than 96 percent of the density of the laboratory-prepared specimens.

Sliding scale pay factors for pavements, which fail to meet specified densities, are listed in Table 6 below, and shall be applied to each lot.

**TABLE 5. SLIDING SCALE PAY FACTORS**

<table>
<thead>
<tr>
<th>Average Percent Density</th>
<th>Percent Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>96.0 and greater</td>
<td>100</td>
</tr>
<tr>
<td>95.0 – 95.9</td>
<td>95</td>
</tr>
<tr>
<td>94.0 – 94.9</td>
<td>90</td>
</tr>
<tr>
<td>93.0 – 93.9</td>
<td>75</td>
</tr>
<tr>
<td>Less than 93.0</td>
<td>Reject</td>
</tr>
</tbody>
</table>

4.13 **SAMPLING PAVEMENT.** The Engineer’s representative or laboratory shall obtain core samples for determination of the density of completed pavements. The size, number, and locations of the samples will be as directed by the Engineer. Samples shall be neatly cut with a saw, core drill, or other approved equipment. Cores that are clearly defective shall be resampled.

The Engineer will perform all tests necessary to determine conformance with requirements specified in this item. The costs for failing tests will be charged to the Contractor.

(a) **Resampling.** Resampling of the pavement for density will be allowed if the Contractor requests in writing, resampling and retesting of a lot of material within 48 hours after receiving the written test results from the Engineer. A retest shall consist of all the sampling and testing procedures contained in paragraphs 4.12c, d, and e. Only one resampling per lot will be permitted.

4.14 **SURFACE TESTS.** The Contractor shall make tests for conformity with the specified crown and grade immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.
The finished surface shall not vary more than ¼ inch for the surface course when tested with a 16-foot straightedge applied parallel with, or at right angles to, the centerline.

After the completion of final rolling, the smoothness of the course shall be tested by the Engineer; humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective work and replacing with new material, as directed by the Engineer. This shall be done at the Contractor’s expense.

The finished surfaces of bituminous courses shall not vary from the grade line, elevations, and cross sections shown on the contract drawings by more than ½ inch. The Contractor shall correct pavement areas varying in excess of this amount by paving and replacing the defective work. Skin patching will not be permitted.

4.15 TOLERANCE IN PAVEMENT THICKNESS. The thickness of the pavement shall be determined by average caliper measurement of cores tested in accordance with AASHTO T 148.

Pavement thickness shall not be less than the specified minimum thickness.

For the purpose of determining the thickness of pavement, units to be considered separately are defined as 1,000 linear feet of pavement in each paving lane starting from the end of the pavement bearing the smaller station number. The last unit in each lane shall be 1,000 feet plus the fractional part of 1,000 feet remaining. One core shall be taken at random in each unit. When the measurement of the core from a unit is not deficient from the specified minimum thickness, full payment will be made.

When the measurement of any core is less than the specified minimum thickness, the actual thickness of the pavement in this area shall be determined by taking additional cores at not less than 10-foot intervals parallel to the centerline in each direction from the affected location, until in each direction core is found which is not deficient. Areas found deficient in thickness shall be removed and replaced with surfacing of the minimum thickness specified.

Cores shall be taken at the discretion of the Engineer.

No additional payment shall be made for any pavement which has a thickness in excess of that shown on the plans.

END OF SECTION 32 11 00
SECTION 32 17 13

PARKING BUMPERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Precast concrete parking bumpers and adhesive.

1.2 ACTION SUBMITTALS

A. Product Data: Submit descriptive literature completely describing precast concrete parking bumpers and adhesive.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Substitutions: Comply with Section 01 25 00.

2.2 MATERIALS

A. Precast Concrete Parking Bumpers:
   1. Type: 8-1/2" wide x 6" high x 72" long, semicircular in cross section; reinforced with two 3/8" diameter bar.
   2. Exposed Surface: Factory cast finish.
   3. Concrete Compressive Strength: 4,500 psi at 28 days.

B. Adhesive for Concrete: Epoxy as recommended by bumper manufacturer complying with Texas State Department of Highways and Public Transportation (SDHPT), 1982 Standard Specifications for Construction of Highways, Streets and Bridges, Item 575 Epoxy Adhesive.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive bumpers.

B. Buff, grind, sandblast or use other acceptable methods to clean concrete surfaces free of dirt, curing compound, grease, oil, moisture, loose, unsound pavement and other material which would adversely affect bond of adhesive.

3.2 INSTALLATION

A. Install parking bumpers in accordance with manufacturer's instructions.
B. Concrete Areas:
   1. Attach parking bumpers on concrete paved surfaces with two 5" diameter spots of epoxy adhesive for each parking bumper.
   2. Apply wet epoxy so that 100 percent of bonding areas are in contact with bumpers and of sufficient thickness over entire diameter of each adhesive spot.

3.3 CLEANING

   A. Clean excess adhesive off parking bumpers and paved surfaces.

END OF SECTION
SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1: GENERAL

1.1 GENERAL. This Section includes the following: Furnish and install all painted lines, directional arrows, handicapped symbols, or similar markings on paved surfaces, as shown on the drawings or specified herein, as required by jurisdiction having authority, and as required to complete the work.

PART 2: PRODUCTS

2.1 TRAFFIC MARKING PAINT. Acrylic Waterborne Paint or Low Volatile Organic Compound (VOC) solvent base paint, lead and chromate free, ready-mixed, cold applied traffic marking paint, white or yellow color as designated on the plans for striping and lane markings, white and blue as international handicapped parking symbols. Acceptable products include Devoe Exterior “Safety Line” or approved equal.

PART 3: EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.2 PREPARATION

A. Surface Preparation: Allow fresh pavement surfaces to weather at least 30 days prior to application of traffic marking paint.

3.3 APPLICATION

A. Traffic Marking Paint: Unless otherwise indicated, apply traffic marking paint in nominal 4” wide stripes at the rate of 100 to 110 sf/gal

1. Unless otherwise indicated, apply traffic markings in nominal 4” wide stripes with clear and sharp dimensions. See drawings for striping patterns, directional arrows and symbols.

2. Unless otherwise indicated, use yellow markings at lane striping and directional symbols, white markings at parking striping and white and blue markings at international handicapped symbols.

3. Comply with ANSI 117.1 and ADA requirements for graphic symbols, stall widths, and access aisles at handicapped parking spaces. Provide approved templates for symbols and directional arrows.

END OF SECTION 32 17 23
SECTION 32 31 13

CHAIN LINK FENCE AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Exterior galvanized polyvinyl chloride (PVC) coated steel chain link fence, complete with framework, fittings, swing gates, and mounting plates, and closures.

1.2 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM A 121 - Specification for Metallic-Coated Carbon Steel Barbed Wire.
   2. ASTM A 123 - Zinc Coating on Iron and Steel Products.
   3. ASTM A 392 - Zinc-Coated Steel Chain-Link Fence Fabric.
   5. ASTM F 668 - Polyvinyl Chloride (PVC) Coated Steel Chain Link Fence Fabric.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data for materials.
B. Shop Drawings: Submit shop drawings including layout drawings, location and spacing of posts, details of gates.
C. Samples: Submit samples as requested by Architect.
D. Certification: Submit certification from manufacturer that materials supplied conform to specifications, including weave style, size of mesh, diamond count, wire size, height of fabric, selvage, and fabric length.
E. Operation and Maintenance Date: submit data for gate operators.

1.4 DELIVERY, STORAGE AND HANDLING

A. Each length of fabric shall be tightly rolled and firmly tied. Each shipment of fabric shall be identified to class of coating, mesh size, core size of wire, height and length of fabric in each roll, ASTM A 392, and name or mark of manufacturer.

1.5 COORDINATION

A. Coordinate installation with electrical requirements.
1.6 PROJECT/SITE CONDITIONS

A. Do not begin fence installation before completion of paving and striping operations.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Substitutions: comply with Section 01 25 00.

2.2 MATERIALS AND COMPONENTS

A. Fabric: Chain link wire fabric, No. 9 AWG (0.148") gage steel, ASTM A 392, Class 2 galvanized coating; woven into 2" mesh, top and bottom selvage knuckled.
   1. Polyvinyl Chloride (PVC) Finish: Comply with ASTM F 668, with core wire diameter (gage) measured prior to application of PVC coating with not less than 0.40 oz. zinc per sq. ft. of uncoated surface on 6 gage wire and not less than 0.30 oz. zinc per sq. ft. of uncoated surface on 9 and 11 gage wire. Black.
   2. Class 2a, minimum 0.015-inch, maximum 0.025-inch-thick PVC coating thermally bonded and adhered to a cured primer applied over zinc-coated steel core wire.

B. Framework: Hot-dipped galvanized steel pipe conforming to ASTM F 1083, plain ends, structural weight (schedule 40) with not less than 1.8 oz. zinc per sq. ft. of surface area coated.

C. Fittings: ASTM F 626, malleable iron to fit over outside of posts and to accommodate top rail.

D. Stretchers: 1/4" x 3/4" steel bar, 0.65 lbs./lin.ft. tension; preformed tension bands, beveled outside edge.

E. Tension Wire: 7 gage high carbon steel wire, 0.80 oz./sq.ft. galvanized coating.

F. Fabric Ties: Preformed No. 11 gage galvanized wire.

G. Truss Rods: 3/8" O.D. solid steel rod, 0.40 lbs./lin.ft.; provide turnbuckles.

H. Grout:
   1. Non-shrink, non-metallic.
   2. Acceptable Product:
      a. N-S Grout by Euclid Chemical Co.
      b. Duragroup by L & M Construction Chemicals, Inc.
      c. Masterflow 713 by Master Builders Technologies.

2.3 FABRICATION


B. Top and Brace Rails: 1.66" O.D. pipe.

C. End, Corner and Pull Posts: 2.875" O.D. pipe.
D. Swing Gates Frame:
1. Gate Posts - 5'-0" wide gate: 3" O.D. pipe.
2. Gate Posts - 6'-0" to 12'-0" wide gate: 4" O.D. pipe.

E. Continuously weld frame or assembled with heavy malleable castings. Galvanize welded frames after fabrication. Locate ventilation holes on bottom sides of framing members. Finish gate fabric same as adjacent panels. Brace and truss gates as recommended by manufacturer to prevent sagging, bucking, and weaving.

PART 3 - EXECUTION

3.1 CONCRETE FOOTINGS

A. Excavation for posts shall provide 3'-6" concrete depth with 3'-0" post embedment. Dispose of waste material from excavations as directed. Clean post holes of loose material.

B. Place line post footings with 9: minimum diameter. Place gate, terminal and corner post footings with 12" minimum diameter. Set posts vertically in concrete base with 28-day compressive strength of 2,000 psi. Compact concrete by hand tamping with rod of sufficient length to reach bottom of post.

C. Finish top of concrete base with 1" crown from post to edge of base at finished grade.

D. Cure concrete 72 hours before performing any further work.

3.2 SETTING POSTS

A. Set line posts on centers as detailed on drawings in line of fence. Set terminal, corner and gate posts at required locations. Anchor posts by core drilling slab and grouting in.

B. Install top rail along top of fence, with rail couplings to match centers of line posts.

C. Extend horizontal rail brace and adjustable diagonal bracing to first adjacent line post. Provide at each terminal, corner, brace and gate post.

D. Gates:
1. Leaves: Provide intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction.
2. Fabric:
   a. Attach fabric to gate frame ends by use of bolt hooks, stretcher bar bands and stretcher bars, or by other methods standard with manufacturer, except that welding fabric to gate frame will not be permitted.
   b. Attach top and bottom of fabric with wire ties at intervals not exceeding 12" on centers.
3. Hardware Supports
   a. Perform welding in accordance with AWS D1.1.
   1) Dress exposed welds smooth and prepare for galvanizing.
4. Galvanize gate assemblies in accordance with ASTM A 123.
E. Pull fabric taut and secure to rails close to both sides of each post and at intervals of not
more than 24" on centers and to intermediate posts at intervals of not more than 14" on
centers with wire ties. Attach fabric to terminal, corner, brace and gate posts with stretcher
bars and stretcher bar bands. Space bands equally on stretcher bars at 14" on center
maximum. Install tension wire shall at bottom of fence; securely fastened to fabric at 12" on
centers and to each post.

F. Hardware: Install gate hardware in accordance with manufacturer's recommendations to
provide smooth operation of gates and to provide secure locking where required.

3.3 ADJUSTING

A. Adjust and lubricate gates to provide smooth operation.

B. Verify proper operation of safety edge and adjust as necessary.

END OF SECTION
SECTION 32 31 19

DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Decorative metallic-coated-steel tubular picket fences.
2. Swing gates.
3. Horizontal-slide gates.

1.2 REFERENCES

A. American Architectural Manufacturers Association
1. AAMA 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

B. ASTM International
1. ASTM A 29/A 29M: Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for
2. ASTM A 36/A 36M: Specification for Carbon Structural Steel
5. ASTM A 123/A 123M: Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
6. ASTM A 153/A 153M: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
7. ASTM A 500/A 500M: Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
8. ASTM A 510: Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
10. ASTM A 653/A 653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
11. ASTM A 780/A 780M: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
12. ASTM A 1008/A 1008M: Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardeneable
14. ASTM C 387/C 387M: Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
16. ASTM F 2408: Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets

C. Builders Hardware Manufacturers Association
   1. BHMA A156.1: Butts and Hinges
   2. BHMA A156.3: Exit Devices
   3. BHMA A156.5: Auxiliary Locks and Associated Products
   4. BHMA A156.13: Mortise Locks and Latches
   5. BHMA A156.17: Self Closing Hinges and Pivots
   6. BHMA A156.31: Electric Strikes and Frame Mounted Actuators

D. Master Painters Institute

E. National Association of Architectural Metal Manufacturers
   1. NAAMM MBG 531: Metal Bar Grating Manual

F. National Ornamental & Miscellaneous Metals Association
   1. NOMMA Guideline 1: Joint Finishes

G. NFPA
   1. NFPA 70: National Electrical Code
   2. NFPA 780: Standard for the Installation of Lightning Protection Systems

H. SSPC: The Society for Protective Coatings
   1. SSPC-PA 1: Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel
   2. SSPC-SP 5/NACE No. 1: Joint Surface Preparation Standard SSPC-SP 5/NACE No. 1: White Metal Blast Cleaning
   3. SSPC-SP 6/NACE No. 3: Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning

I. Underwriters Laboratories Inc.
   1. UL 325: Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems
   2. UL 467: Safety Grounding and Bonding Equipment

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
   1. Include diagrams for power, signal, and control wiring.

C. Samples: For each fence material and for each color specified.
   1. Provide Samples 12 inches (300 mm) in length for linear materials.
   2. Provide Samples 12 inches (300 mm) square for bar grating.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Include 10-foot (3-m) length of fence complying with requirements.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE METALLIC-COATED-STEEL TUBULAR PICKET FENCES

A. Decorative Metallic-Coated-Steel Tubular Picket Fences: Comply with ASTM F 2408 for light industrial (commercial) application (class) unless otherwise indicated.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Montage II, Majestic Style by Ameristar or comparable product by one of the following:
      a. BetaFence USA LLC.
      b. Fortress Iron.
      c. Hill & Smith Inc.
      d. Iron Eagle Industries, Inc.
      e. Iron World Manufacturing, LLC.
f. Master Halco.
g. Merchants Metals.
h. Virginia Railing and Gates, LLC.
i. Xcel Fence.

B. The fence system shall conform to Welded and Rackable Ornamental Steel, flush bottom rail treatment, 3-Rail style.

C. Posts:
1. End and Corner Posts: Square tubes 2-1/2 by 2-1/2 inches (64 by 64 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.

D. Fence Panels and Posts: Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.90 oz/ft2 (276 g/m2), Coating Designation G-90.

E. Rails: Double-wall channels.
1. Size: The rails shall be steel channel, 1.75” x 1.75” x .105”.
2. Metal and Thickness: 0.079-inch (2.01-mm) nominal-thickness, metallic-coated steel sheet or 0.075-inch (1.90-mm) nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

F. Pickets: Square tubes.
1. Material for pickets shall be 1” square x 14 Ga. Tubing.
2. Terminate tops of pickets at top rail for flush top appearance.
3. Picket Spacing: Picket holes in the rail shall be spaced 4.715” o.c. clear, maximum.

G. Fasteners: Manufacturer’s standard concealed fastening system.

H. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.

I. Interior surface of tubes formed from uncoated steel sheet shall be coated with zinc-rich thermosetting coating to comply with ASTM F 2408.

J. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

K. Finish: The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Black. Organic coating complying with requirements in ASTM F 2408.
L. Fabrication: Assemble fences into sections by welding pickets to rails.
   1. Fabricate sections with clips welded to rails for field fastening to posts.
   2. Drill clips for fasteners before finishing.

M. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

2.3 SWING GATES

A. Gate Configuration: As indicated

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Galvanized-Steel Frames and Bracing: Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.

E. Frame Corner Construction: Welded.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for adjacent fence.

H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

J. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
   1. Function: As selected and approved by Architect.
   2. Material: Malleable iron; galvanized.

K. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.
   1. Function: As selected and approved by Architect.
   2. Material: Brass or bronze.
   3. Levers: Cast, forged, or extruded brass or bronze.
   4. Mounting Box: Configuration necessary to enclose locks. Fabricate from 1/8-inch- (3.2-mm-) thick, steel plate; galvanized.

L. Electric Strikes: BHMA A156.31, Grade 1, of configuration required for use with lock specified, fail-secure, and suitable for exterior use.
   1. Mounting Plate: Configuration necessary for mounting electric strikes. Fabricate from 1/8-inch- (3.2-mm-) thick, steel plate; galvanized.
2. Mounting: Mortise into post.

M. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use.
1. Function: As selected and approved by Architect.
2. Mounting Channel: Bent-plate channel formed from 1/8-inch- (3.2-mm-) thick, steel plate. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending 1/8 inch (3.2 mm) beyond push pad surface.

N. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- (19-mm-) diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

O. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

P. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

Q. Metallic-Coated-Steel Finish: Galvanized finish.

R. Steel Finish: Shop painted.

2.4 HORIZONTAL-SLIDE GATES

A. Gate Configuration: As indicated

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Galvanized-Steel Frames and Bracing: Square tubes 3 by 3 inches (76 by 76 mm) formed from 0.108-inch (2.74-mm) nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch (2.66-mm) nominal-thickness steel sheet and hot-dip galvanized after fabrication.

E. Frame Corner Construction: Welded.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for adjacent fence.

H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

I. Additional Rails: Provide as indicated, complying with requirements for fence rails.
J. Infill: Comply with requirements for adjacent fence.

K. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
   1. Treillage: Provide iron castings of pattern indicated between each pair of pickets.
      Finish as specified for adjacent fence.

L. Overhead Track Assembly: Manufacturer's standard track, with overhead framing
   supports, bracing, and accessories, engineered to support size, weight, width, operation,
   and design of gate and roller assemblies.

M. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for
   each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for
   pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock
   accessible from both sides of gate.

N. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
   1. Function: As selected and approved by Architect.
   2. Material: Malleable iron; galvanized.

O. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- (19-mm-)
   diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates.
   Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed
   positions.

P. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely
   sanded joint, some undercutting and pinholes okay.

Q. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip
   galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to
   comply with ASTM A 153/A 153M.

R. Metallic-Coated-Steel Finish: Galvanized finish.

S. Steel Finish: Shop painted.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy
   welded.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements
   in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength
   of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate
   size.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout
   complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer
   for exterior applications.
2.6 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   1. Material above Finished Grade: Copper.
   2. Material on or below Finished Grade: Copper.
   3. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.
   1. Connectors for Below-Grade Use: Exothermic-welded type.
   2. Grounding Rods: Copper-clad steel.
      a. Size: 5/8 by 96 inches (16 by 2440 mm).

2.7 METALLIC-COATED-STEEL FINISHES

A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

C. Powder Coating: Immediately after cleaning and pretreating, apply two-coat finish consisting of epoxy prime coat and TGIC polyester topcoat, with a minimum dry film thickness of 2 mils (0.05 mm) for topcoat. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of 4 mils (0.10 mm).
   2. Comply with surface finish testing requirements in ASTM F 2408.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 01 71 23 "Field Engineering."

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails to posts.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   a. Exposed Concrete: Extend 2 inches (51 mm) above grade. Finish and slope top surface to drain water away from post.
   b. Concealed Concrete: Top 2 inches (51 mm) below grade as indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.

4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch (20 mm) larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
   a. Extend posts at least 5 inches (125 mm) into sleeve.
   b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch (20 mm) larger than outside diagonal dimension of post.
   a. Extend posts at least 5 inches (125 mm) into concrete.
   b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.

6. Mechanically Driven Posts: Drive into soil to depth of 30 inches (762 mm). Protect post top to prevent distortion.
7. Space posts uniformly at 6 feet (1.83 m) o.c.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:
   1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways:
      a. Gates and Other Fence Openings: Ground fence on each side of opening.
         1) Bond metal gates to gate posts.
         2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

D. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

E. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.
3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
   1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
   2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
   3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.
SECTION 33 00 00 - SITE UTILITIES

PART 1: GENERAL

1.1 WORK INCLUDED

A. This work includes layout, trenching and other excavation, trench protection provisions, providing and installing all necessary site utility line piping and appurtenances, from the points of connections to public utilities to connections with building lines within 5’ (5 feet) of buildings for domestic water service, fire protection lines, and sanitary sewer service. This work also includes providing and installing various conduits and sleeving for installation of other utilities, including electrical secondary and telephone service runs and irrigation piping installed by others, and providing and installing drawstrings or pull-wires in these sleeves as may be necessary.

B. Contractor shall arrange for utility connections with the proper authorities, and shall bear all expenses associated with permits, connections, or inspections required by said authorities.

1.2 REFERENCE STANDARDS

A. At a minimum, comply with applicable provisions of the latest edition of the Uniform Plumbing Code (UPC) and its amendments as adopted by the local jurisdiction. Comply with all other applicable codes, regulations, ordinances, statutes, or laws as established at time of construction by any and all entities having jurisdiction.

B. ASTM is the American Society for Testing and Materials; references standards refer to the latest versions thereof.

C. AWWA is the American Water Works Association; referenced standards refer to the latest versions thereof.

1.2 QUALITY ASSURANCE

A. Submit manufacturer's data on all materials to be incorporated into the work.

B. All pipe, fittings, and other appurtenances shall be new and unused.

1.4 WARRANTY

A. Standard project warranty provisions specified elsewhere apply to work of this section.

B. Warranty period shall start on date of Substantial Completion.

PART 2: PRODUCTS

2.1 PIPE

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Canyon ISD ES #9&10
A. Domestic Water Pipe, up to and including 4" (four inch) I.D.: ASTM D2241 PVC, minimum wall thickness SDR-26, or ASTM D 1785 minimum sch-40: integral bell and spigot with elastomeric gaskets meeting ASTM F477 and joints meeting ASTM D3139; 4" (four inch) I.D. and larger; AWWA C900, DR-18, integral; bell and spigot with gasket joints per above; or other UPC approved pipe and fittings subject to the approval of the Engineer. Plans shall instruct as to preferred material.

B. Fire Protection Water Pipe: ASTM D2241 PVC, DR-18, integral bell and spigot with gasket joints meeting ASTM F477 and ASTM D3139; or cement-lined bituminous coated ductile iron pipe meeting ASSA C104, C150, and C151 specifications with elastomeric gaskets meeting AWWA C111; or other pipe and fittings meeting National Fire Protection Association standards as approved by the local Fire Marshall and subject to the approval of the Engineer. Plans shall instruct as to preferred material.

C. Sanitary Sewer Pipe: ASTM D3034 PVC, minimum SDR-35, integral bell and spigot with elastomeric gaskets meeting ASTM D477 and joints meeting ASTM D3212; or other UPC approved pipe and fittings subject to the approval of the Engineer. See plans for design requirements. Plans shall instruct as to preferred material.

D. Sleeves and Conduits: minimum Schedule 40 PVC or galvanized steel.

E. Storm Sewer Pipe: ADS HP storm Corrugated Polypropylene Drainage Pipe except where otherwise noted on plans.

2.2 ACCESSORY MATERIALS

A. All materials and appurtenances required in conjunction with the work of this section shall be manufactured specifically for the intended use and shall meet all applicable codes, regulations and standards of all authorities having jurisdiction.

B. Sanitary sewer cleanouts on exterior lines shall be installed at locations as required by the UPC and intervals no greater than 100' (one hundred feet). The fitting at the sewer main shall be concrete encased. An approved brass cleanout ferrule and plug shall be installed in a minimum 18" (eighteen inch) square by 7" (seven inch) thick concrete slab set to finished grade. Cleanouts shall be 4" (four inch) diameter.

PART 3: EXECUTION

3.1 PREPARATION

A. Permits: Obtain all required permits and arrange for all necessary work to be performed by municipal or utility company employee. Pay for any fees associated with permits, taps, meters, inspections, or other connection fees assessed by the city or utility company associated with making building service connections to the city or utility owned mains.

B. Before commencing pipe excavations:

1. Have all known underground utilities located within the excavation area.
2. Stake proposed route of each utility line.

3. Verify horizontal and vertical locations of items critical to the alignment and grade of proposed utility lines. Calculate sanitary sewer line grades and confirm compliance with the Drawings and specifications.

4. Confirm availability of all utilities to be in substantial agreement with the Drawings.

5. Notify Engineer of any conditions encountered that may require significant rerouting of site utility piping before commencing or continuing. Otherwise, make minor adjustments as needed and make written record of same.

3.2 EXCAVATING FOR SITE UTILITIES

A. Trenches and excavating shall be made to the lines and grades indicated on the Drawings and as necessary to complete the utilities installations. There shall be no separate classification or payment for excavated materials, and all materials encountered shall be removed as necessary.

B. Rock or other unyielding materials that may be encountered shall be removed to provide a minimum clearance of 6" (six inches) to all points of any pipe or appurtenances being installed.

C. Trench and excavation protection shall be provided per Department of Labor/OSHA 29 CFR Part 1926, "Occupational Safety and Health Standards - Excavations", and any other applicable law, regulation, or ordinance.

D. All adjacent property and improvements shall be protected during the prosecution of work under this section. Provide whatever temporary support, bracing, or other measures necessary, and restore any damaged or disturbed items to the satisfaction of the Owner of the item(s) and as directed by the Engineer.

E. Provide barricades, flagmen, lighting, signs, or any other items necessary to assure the safety of the public and workmen.

F. Take precautions to avoid interruptions of access to and from adjoining properties whenever possible. Do not obstruct public rights-of-way without specific permission from the governing authority having jurisdiction.

G. Trenches or excavations requiring the cutting of existing pavements shall be kept to a minimum size in conformance with the work necessitating the cut. Backfill the excavation and restore the pavement as indicated on the Drawings, or to as good as or better condition than the adjacent pavement.

3.3 LAYING PIPE

A. In general, install pipe in the prepared trench bottom per recommendations of the manufacturer and UPC requirements based on actual conditions encountered at the project site.
B. Provide concrete thrust blocking for water line fittings and appurtenances per UPC requirements. Thrust blocking shall be installed against sound undisturbed earth and the concrete shall have a minimum 28-day $f'_c = 2,500$ psi

C. Keep interiors of all piping and appurtenances clean and free of dirt or other deleterious materials.

D. Install piping as nearly as practicable to the lines and grades indicated on the Drawings. Maintain a minimum of 10' (ten feet) separation between water and sanitary sewer lines. Where these lines cross, lay water lines at least 3' (three feet) above sewer lines. This clearance may be reduced to a minimum of 12” (twelve inches) provided the sewer line is constructed of cast or ductile iron pipe, or PVC pressure pipe meeting AWWA specifications for potable water pipe, for parts of the sewer line within 10' (ten feet) of the water line.

E. Provide underground warning tapes above all buried utility pipe lines. Tape shall be heavy gauge (0.004" or greater) polyethylene film, color coded according to APWA standards:

- Water Lines......................Blue
- Sewer Lines.....................Green
- Gas Lines......................Yellow
- Telecommunications.............Orange
- Electric Lines...................Red

Minimum tape width shall be 2” (two inches). Install warning tapes no less than 12" (twelve inches) above the top of the buried lines.

3.4 BACKFILLING TRENCHES AND EXCAVATIONS

A. In general, do not begin backfill until all lines have been tested.

B. Embedment and initial backfill shall be as indicated on the Drawings or as recommended by the manufacturer or required by the reference standard for the size and type of pipe or appurtenance installed.

C. Final backfill shall be placed in lifts not exceeding 8" (eight inches) and thoroughly compacted to density at least equivalent to the surrounding native material. In areas to be paved, lifts shall not exceed 6" (six inches).

D. All backfill shall be free of large rocks or stones, broken concrete, trash, weeds or other organic matter, or any other deleterious materials.

E. Restore final surfaces of trenches to approximate original grade.

3.5 TESTING
A. Domestic Water Lines

1. Hydrostatic Pressure Leakage Tests
   
a. Pressure During Test: After the pipe has been laid, the line shall be subjected to a hydrostatic pressure test and leakage test. The lines shall be tested at 100 psig pressure.

b. Duration of Test: The duration of each test shall be minimum of 4 (four) hours.

   c. Procedure: Each newly laid pipe, or valved section thereof, shall be slowly filled with water to the specified test pressure measured at the point of lowest elevation. Pressure shall be applied and maintained by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, and all necessary appurtenances and labor shall be furnished by the Contractor.

   As the line is being filled and before applying the test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at points of highest elevation. After the test, the taps shall be tightly plugged.

   During the time the test pressure is on the pipe, the line shall be carefully checked at regular intervals for breaks or leaks. Any joints showing leaks shall be repaired and cracked of defective pipes or fittings shall be removed and replaced. The test shall be repeated until satisfactory results are obtained.

   d. Leakage Test: After all defects have been satisfactorily repaired and all visible leaks stopped, a leakage test shall be made on each newly laid pipe or valved section thereof to determine the quantity of water lost by leakage. The Contractor shall furnish all labor, material, and equipment required for making the test. The leakage shall be determined by measuring the quantity of water supplied to each test section of the lines necessary to maintain the test pressure. No pipe installation will be accepted until or unless the leakage as determined by test does not exceed 2 (two) quarts per hour per 100 (one hundred) gasketed joints, distributed over all joints, and regardless of pipe diameter.

2. Sterilization of Water Lines

   a. The Contractor shall furnish all labor, equipment and material necessary for the chlorination of the new pipe lines which shall be sterilized before being placed in service. The lines shall be sterilized by the application of the chlorinating agent. The chlorinating agent may be a liquid chlorine, liquid chlorine gas-water mixture, or a calcium hypochlorite solution, which shall be fed into the lines through a suitable solution-feed device, or other methods approved by the Engineer.

   b. The chlorinating agent shall be applied at or near the point from which the line is being filled, and through a corporation stop or other approved connection inserted in the horizontal axis of the newly laid pipe. The water being used to fill the
line shall be controlled to flow into the section to be sterilized very slowly, and
the rate of application of the chlorinating agent shall be in such proportion of wa-
ter entering the pipe that the chlorine dose applied to the water entering the line
shall be at least 100 (one hundred) parts per million. The treated water shall be
retained in the pipe lines for a period of not less than 24 (twenty-four) hours.

  c. Completed lines shall be flushed until the chlorine residual stabilizes at the public
water system residual, typically 0.2 parts per million or less.

B. Fire Protection Water Lines

  1. In general, follow same procedures as for Domestic Water Lines, except test pressure
shall be 150 psig pressure.

  2. All installation, testing, and procedures shall meet National Fire Protection Associa-
tion standards as approved by the local Fire Marshall and subject to the approval of
the Engineer.

C. Sanitary Sewer Lines

  1. Sewer lines may be tested by either conducting a water exfiltration test or a low-
pressure air test. Contractor shall supply all equipment and labor necessary to satis-
factorily complete the test.

  2. Water Exfiltration Test

    a. The lower end of the section to be tested shall be closed with a watertight device.
The upper end of the section to be tested shall be filled with water to a point 4'
(four feet) above the pipe invert.

    b. The allowable leakage by exfiltration shall not exceed 200 (two hundred) gal-
lons/inch diameter/mile/day. The leakage shall be measured

    c. The Contractor shall repeat the 4 (four) hour exfiltration test after repairs until an
acceptable
leakage rate is attained. All repairs required shall be at the Contractor's expense.

  3. Low-Pressure Air Test

    a. The low-pressure air test shall be conducted in accordance with the provisions of
UNI-B-6, "Recommended practice for Low-Pressure Air Testing of Installed

    b. The Contractor shall repeat the low-pressure air test after making any necessary
repairs until an acceptable pressure drop for the test is attained. All repairs re-
quired shall be at the Contractor's expense.

3.6 REPORTING OF TEST RESULTS
A. **Water Lines**

1. Provide written report to Engineer of all tests, including failed tests, if any, and note repairs made.

2. Report date and location of all tests, and include calculations for allowable and actual leakage, line size and service, test pressure, and date lines placed in service.

B. **Sanitary Sewer Lines**

1. Provide written report to Engineer of all tests, including failed tests, if any, and note repairs made.

2. Report date and location of all tests, and include test method, line size, and calculations for allowable and actual exfiltration or air-pressure drop.

**END OF SECTION 33 00 00**