PROJECT MANUAL

VOLUME TWO

Roswell Independent School District

NANCY LOPEZ ELEMENTARY SCHOOL

PSFA Project No. P19-010

December 22, 2023

architects
PA Architects

PROJECT MANUAL
VOLUME TWO

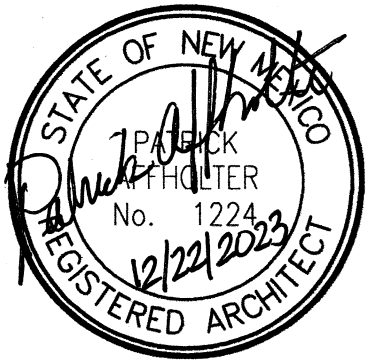
DESIGN DEVELOPMENT SUBMITTAL

NANCY LOPEZ ELEMENTARY SCHOOL

Roswell Independent School District
300 N. Kentucky
Roswell, New Mexico 88201
575-627-2500

December 22, 2023

PSFA Project No. P19-010



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NANCY LOPEZ ELEMENTARY SCHOOL

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ROSWELL, NEW MEXICO

VOLUME TWO

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PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Furnish all service tools, equipment, etc., which are required for the complete installation of all Fire Suppression Work, as indicated on the Drawings, and specified herein. Fire Suppression work indicated on the Drawings and/or specifications covering other trades shall conform to Division 21 of these Specifications.

B. Work or equipment not indicated or specified, which is necessary for the complete and proper operation of the Fire Suppression systems, shall be accomplished without additional cost to the Owner.

C. Furnish all labor and materials required for fire suppression service and control connections to all the various items of equipment requiring fire suppression service throughout the project shown on the Contract Drawings (even if not shown on the Fire Suppression Drawings). Coordinate with other trades for the installation of required connections and service.

1.3 FIRE SUPPRESSION DIVISION INDEX

210500 GENERAL FIRE SUPPRESSION REQUIREMENTS

211300 AUTOMATIC SPRINKLER SYSTEMS

PART 2 – PRODUCTS: Not used.

PART 3 – EXECUTION: Not used.

END OF SECTION 21 00 00

SECTION 21 05 00 - GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: General Mechanical Requirements specifically applicable to Division 21 sections in addition to Division 1 - General Requirements.

B. Scope:

1. The work covered by this division consists of performing all operations in connection with the installation of heating, cooling, ventilating, and plumbing including site utility work as indicated under this section. This entire section applies to all mechanical work and all mechanical sections of these specifications. This Contractor shall read and comply with all sections of these specifications including all General and Special Conditions.

1.2 REFERENCES

A. Standard Requirements:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. All work shall be executed in accordance with the local and state codes, ordinances, and regulations governing the particular class of work involved. This Contractor shall be responsible for the final execution of the work under this heading to suit these requirements. In the event of a conflict between the various codes and standards, the more stringent shall govern. Where these specifications and accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect/Engineer. The Architect/Engineer shall prepare any supplementary drawings required, illustrating how the work may be installed so as to comply. On approval of the change by the Architect/Engineer, the Contractor shall install the work in a satisfactory manner without additional cost to the Owner. On completion of the various parts of the work, the installation shall be tested by the constituted authorities and approved, and on completion of the work, this Contractor shall obtain and deliver to the Owner final certificates of acceptance. This Contractor shall furnish copies of each certificate to the Architect/Engineer.

C. The Contractor shall secure all permits and licenses for his work and shall pay all fees in connection with such permits and licenses.

D. The contractor shall hold and save the Owner free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

E. Any and all meter deposits and all utility extension costs shall be paid by the Contractor whose work is done in connection with the service that the meter is connected to.

F. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

1. AABC	Associated Air Balance Council
2. ADC	Air Diffusion Council 435 North Michigan Ave. Chicago, IL 60611
3. AGA	American Gas Association 1515 Wilson Boulevard Arlington, VA 22209
4. AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004
5. ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
6. ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers 345 East 47th Street New York, NY 10017
7. ASME	American Society of Mechanical Engineers 345 East 45th Street New York, NY 10017
8. ASPE	American Society of Plumbing Engineers 960 Illuminating Building Cleveland, OH 44113
9. ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
10. AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
11. AWS	American Welding Society 2501 NW 7th Street Miami, FL 33125
12. CISPI	Cast Iron Soil Pipe Institute 1499 Chain Bridge Road McLean, VA 22101

13. FM	Factory Mutual System 1151 Boston-Providence Turnpike Norwood, MA 02062
14. FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Building 197 Washington, DC 20407
15. NBFU	National Board of Fire Underwriters 5530 Wisconsin Avenue, Suite 750 Chevy Chase, Maryland 20815
16. NEC	National Electric Code (of NFPA)
17. NEBB	National Environmental Balancing Bureau 8224 Old Courthouse Road Vienna, VA 22180
18. NEMA	National Electrical Manufacturer's Association 2101 L Street, NW Washington, DC 20037
19. NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
20. NSF	National Sanitation Foundation Box 1468 Ann Arbor, MI 48106
21. OSHA	Occupational Safety and Health Administration U.S. Department of Labor
22. PDI	Plumbing and Drainage Institute 5342 Boulevard Place Indianapolis, Indiana 46208
23. SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 8224 Old Courthouse Road Vienna, VA 22180
24. TIMA	Thermal Insulation Manufacturers Association Technical Services 1420 King Street Alexandria, VA 22314

25. UL — Underwriters Laboratories, Inc.
333 Pfingston Road
Northbrook, IL 60062

G. Underwriters Laboratories Inc. (UL): All materials, appliances, equipment, devices or appurtenances shall conform to the applicable standards of Underwriters Laboratories Inc., where such standards have been established.

1.3 DRAWINGS

A. Drawings and specifications shall be considered as cooperative, and work or materials called for by one and not mentioned in the other, or vice versa, shall be done and furnished as though treated by both.

B. In the cases of discrepancies in figures, drawings, or specifications, the Architect/Engineer shall be notified immediately, and his decision shall determine the necessary adjustment. Without such decision, said discrepancies shall not be adjusted by the Contractor save only at his expense, and, in case of any settlement or any complication arising from such adjustment to the Contractor, he shall bear all extra expense involved.

C. Should it appear that the work intended to be done, or any of the matters relative thereto, are not sufficiently detailed or explained on the drawings or specifications, the Contractor shall apply to the Architect/Engineer for such further drawings or explanations as may be necessary, allowing a reasonable time for the Architect/Engineer to supply same, and the Contractor shall conform to same as part of the Contract.

D. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, reference shall be made to the Architect\Engineer whose decision shall be final and conclusive. No alleged oral admission, condonation, or inadvertent neglect on the part of the Architect/Engineer will be accepted as an excuse for inferior work.

E. The mechanical plans do not give exact details as to elevations of ductwork and piping, exact locations, etc., and do not show all offsets, control lines, pilot lines, and other installation details. The Contractor shall carefully lay out his work at the site to conform to the structural conditions, provide proper grading of lines, to avoid all obstructions, to conform to details of installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated, satisfactory operational installation.

F. Should the particular equipment which any Bidder proposes to install, require other space conditions than those indicated on the drawings, the Bidder shall arrange for such space with the Architect/Engineer before submitting his bid. Should changes become necessary on account of failure to comply with these details, the Contractor shall make such necessary changes at his (the Contractor's own expense).

G. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans which shall be checked by the Architect/Engineer and approved before the work is started, Contractor before work proceeds. Interference with structural conditions shall be corrected by the Contractor.

H. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

I. Utilities: The location, size, and pressure of utility lines are shown in accordance with the data given this office by others. As Architect/Engineers, we cannot and do not guarantee the accuracy of this data. Each Bidder shall check and verify this data. The points of connection to utility lines are approximate only and shall be verified by each Bidder prior to submitting his Bid.

J. Site visit: The Contractor shall visit the site prior to bidding and satisfy himself as the conditions under which the mechanical systems are to be installed. No subsequent allowance shall be made in his behalf for failure to make such a visit. Contractor shall examine all work noted under the demolition drawings and all new work and shall satisfy himself as to the extent of work required to be completed.

1.4 SYSTEM DESCRIPTIONS

A. Not Used.

1.5 PRIOR APPROVALS

A. Each equipment item for which the Contractor desires to install equipment other than the specific item identified in the equipment schedule or equivalent equipment by manufacturers specifically named in the schedule, the Contractor shall bear full responsibility to prove to the Engineer that the furnished equipment is equivalent to or better than the specified item. Failure to provide such proof will result in rejection of the shop drawing submittal by the Engineer. Prior written or verbal approval by the Engineer of equipment by other manufacturers will not relieve the Contractor of responsibility to provide equivalence. Prior approval is not required, however, any prior approval given is intended only to provide preliminary agreement that the alternate manufacturer may make equipment that complies with the specification requirements and not that all equipment manufactured by him is acceptable.

1.6 SHOP DRAWINGS

A. Shop drawings or fully descriptive catalog data shall be submitted by the Contractor for all items of material and equipment furnished and installed under this Contract. This shall include piping, ductwork, mechanical equipment, plumbing equipment, control items, etc. The Contractor shall submit to the Architect/Engineer a sufficient number of copies of all such shop drawings or catalog data to provide him with as many review copies as he may need, plus three (3) copies for retention by the Architect/Engineer. No materials or equipment shall be installed until officially approved by the Architect/Engineer.

B. Before submitting Shop Drawings to the Architect/Engineer for review, the Contractor shall examine them and satisfy himself that they are correctly representative of the material or equipment to which they pertain. The Contractor shall so note these Drawings before submitting them. The Contractor's review of Shop Drawings is not intended to take the place in any way of the official review of the Architect/Engineer, and the Shop Drawings which have not been reviewed by the Architect/Engineer shall not be used in fabrication or installing any work.

C. The review of Shop Drawings or catalog data by the Architect/Engineer shall not relieve the Contractor from responsibility for deviations from the plans and Specifications unless he has, in

writing, specifically called attention to such deviations as the time of submission and has obtained the permission of the Architect/Engineer thereon, nor shall it relieve him from the responsibility for error of any kind in Shop Drawings. When the Contractor does call such deviations to the attention of the Architect/Engineer, he shall state in his letter whether or not such deviations involve any extra cost. If this is not mentioned, it will be assumed that no extra costs is involved for making the change.

D. After receiving approval on the make and type of materials, the Contractor shall order such materials in sufficient time so that no delay or changes will be caused. This is done to facilitate progress on the job and failure on the part of the Contractor shall render him liable to stand the expense of any and all delays occasioned by failure on this part to provide necessary details. All shop drawings shall be delivered to the Architect/Engineer's office within thirty (30) days from the date of the contract.

E. Shop drawings will be returned unchecked unless the following information is included: reference to all pertinent data in the Specifications or on the drawings, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings.

1.7 SUBMITTALS

A. Submittal data shall be organized in commercial quality, three ring binders with durable and cleanable covers. Product information for each piece of equipment shall be separated by an indexing leaf with clear tabs. The product name and symbol (i.e., AHU/Air Handling Unit) shall be typed on white paper inserts and placed in appropriate tab. Complete data must be furnished showing performance, quality, and dimensions. A signed review by the Architect/Engineer must be obtained before purchasing any equipment.

B. No review of the fire protection system shall be completed without all shop drawings, equipment, hydraulics, etc. being delivered as one package. No exceptions.

C. The following items shall be submitted for review by the Architect/Engineer but are not limited to:

1. Utilities Piping & Materials whether furnishes by the contractor or others.

2. Fire Protection Drawings & Hydraulic Calculations

3. Cross Connection Control Devices

4. Piping Material

5. Fire Protection Equipment – including alarm valve, tamper switch, etc.

6. Ductwork Shop Drawings – as part of fire protection drawings.

1.8 QUALITY ASSURANCE

A. General: Comply with Division 1.

B. Welder Qualifications: Welders shall be certified by the American Society of Mechanical Engineers (ASME) National Certified Pipe for the type of work being performed. Current operators' certificates in accordance with ASME standards shall be on file at the site and shall be available to the Architect/Engineer for examination. Coupons shall be available for review by the Architect and Engineer.

C. Locations of all pipes, ducts, outlets, appliance, etc., as shown on the drawings, are approximate only and are understood to be subject to such revisions as may prove necessary or desirable at the time the work is installed. Each Contractor will be required to install his work with relation to existing building conditions and shall be entirely responsible for the correctness of his work with reference to finished elevations, etc. Piping shown on the drawings is diagrammatic only and their exact locations, depths, and invert elevations shall be as required for proper flow and coordination with other trades.

D. The contract drawing depicts graphically the arrangement of piping and ductwork. Should local conditions necessitate a rearrangement, or if any of the piping or ductwork can be installed to better advantage in a different manner, the Contractor shall, before proceeding with the work, prepare and submit three (3) copies of Drawings of the proposed arrangement for the Architect/Engineer's review.

E. If the Contractor proposes to install equipment, including piping and ductwork, requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the Architect/Engineer review the change before proceeding with the work. The request for such change shall be accompanied by Shop Drawings of the space in question.

F. Each Contractor is responsible for the proper location and size of all slots, holes, or openings in the building structure pertaining to his work, and for the correct location of pipe sleeves.

G. Each Contractor shall coordinate his work with that of all other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipelines which require a stated grade for proper operation. Drainage lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork.

H. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Lubricate all equipment properly in accordance with manufacturer's instructions. Furnish zerk grease fittings on all greaseable bearings.

I. Equipment and Materials: The materials and equipment shall be new and shall be the standard products of the manufacturers regularly engaged in the production of Plumbing, Heating, Cooling, Ventilation, and Fire Protection Equipment, and shall be the manufacturer's latest standard design. Where two or more units of the same class of equipment are required, these units shall be the products of the same manufacturer. However, the component parts of the systems need not be the products of the same manufacturer. Specific equipment specified hereinafter is to be considered a standard of quality and operation. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the drawings. Reference shall be made to the schedules for specific information. The capacities shown are minimum capacities. Variations in the characteristics will be permitted only on written approval of the

Architect/Engineer. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible all items of the same type (i.e., pumps, fans, etc.) shall be by the same manufacturer. Where installation instructions are not included in these specifications or on the plans, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is to be installed.

J. Excavation and Backfilling: This Contractor shall do all necessary excavation and backfill for the installation of the Mechanical systems as may be required. Curb cuts, asphalt and concrete patching, cutting and patching existing floor, etc., shall be part of this Contractor's responsibility. No extra payment will be made for rock excavation. Trenches for all underground piping shall be excavated to the required depths. The bottoms of trenches shall be tamped hard and graded to secure maximum fall. Bell holes shall be excavated to assure the pipe resting for its entire length on solid ground. Should rock be encountered, it shall be excavated to a depth of 6 inches below the bottom of the pipe, and before laying the pipe, the space between the bottom of the pipe and the rock surface shall be filled with gravel, thoroughly tamped. Pipe laid in trenches dug in fill shall be supported down in the trenches and shall be filled. No roots, rocks or foreign materials of any description shall be used in backfilling the trenches. The backfill material shall be identical to the surrounding fill material and shall be placed in 6-inch layer, wetted, and compacted to the density of the adjacent soil. See Division 2 for additional information for site utilities. All surplus materials shall be hauled from the project by the Contractor at his expense.

K. Cutting and Repairing:

1. Responsibility of the Contractor whose work is involved. Coordinate with others to prevent unnecessary cutting and repairing.

2. Lay out and locate equipment, openings, and chases. Install sleeves, inserts, and supports. Arrange with those whose work is involved to do cutting and replacing caused by negligence or error with costs reimbursed by the Contractor at fault. Cutting and replacing of existing work shall be the responsibility of the Contractor whose work is being installed.

3. Removal or terminating connections of existing work which is abandoned or replaced shall also be done hereunder to provide correct and finished work.

L. Foundations: All equipment shall be provided with suitable foundations and supports. It shall be the responsibility of the Contractor to provide for the proper locations of these foundations and supports. This applies to all rooftop equipment also.

1. All concrete foundations required by equipment furnished by the Mechanical Contractor shall be constructed by them (except where otherwise noted) the conformity with the recommendations of the manufacturer of the respective equipment, and with the approval of the Architect/Engineer. All corners of the foundations shall be neatly chamfered. Foundation bolts shall be placed in the forms when the concrete is poured. Allow 1 inch below the equipment base for alignment, leveling and grouting with non-shrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary. After removal of the forms, the surface of the foundation shall be rubbed.

2. Unless otherwise noted, foundations shall be a minimum of 6-inch high. All concrete work performed by these Contractors shall conform entirely to the requirements of the Concrete Specifications which describe this class of work.

M. Code Requirements: Comply with state and local code requirements and ordinances. Call for inspections required by responsible building inspection authority.

N. Applicable Building Codes and Ordinances: Including the latest edition of each code, but not limited to the following:

1. International Building Code.

2. Uniform Mechanical Code.

3. Uniform Plumbing Code.

4. Governing Fire Department Requirements

5. Utility Company Requirements

6. National Fire Protection Association Standards

7. NFPA 70 - National Electrical Code

8. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

9. NEPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

10. NFPA 13 - Sprinkler Systems

11. NFPA 101 - Life Safety

12. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Laden Vapors from Commercial Cooking Equipment

13. NFPA 25 – Standard for the Inspection, Testing & Maintenance of Water Based Fire Protection System

14. NFPA 24 – Stand for Installation of Private Fire Service Main and Their Appurtenances

O. Access Panels

1. Similar to Milcor, or as noted on the drawings, size as required for concealed expansion joints, valving, gauges, balancing dampers, valves, traps, pitot stations, equipment and similar items requiring accessibility. Notify the General Contractor of each access panel location and the required size. Panels shall be proper type for ceiling or wall in which they are installed. The panels shall be furnished under this section of the Specifications, unless otherwise directed, but shall be coordinated to be compatible with walls and ceilings furnished under other sections.

1.9 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1

B. Large Items: Make arrangements with other trades on the job for introduction into the building of equipment too large to pass through finished openings.

C. Acceptance: Check and sign for materials to be furnished by others for installation under Division 15 upon delivery. Contractor shall be responsible for the storage and safekeeping of such materials from time of delivery until final acceptance.

D. Protection: Close ends of pipe and ductwork at the close of each working day during construction to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Protect fixtures and equipment against damage during mechanical work with heavy paper or plastic until final clean-up.

E. Storage: Store equipment in covered enclosure or wrap with weather tight 6 mil Visqeen.

F. Shipping Protection: Protective casings, crating, and coverings to remain in place until start-up of equipment.

1.10 PROJECT CONDITIONS

A. Performance: All systems are to be rated at 3,575 ft. elevation.

1.11 SEQUENCING AND SCHEDULING

A. General: Comply with Division 1.

B. Schedule: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

C. Utility Interruptions: Schedule mechanical utility interruptions with the Architect/Engineer/Owner minimum of seven (7) days prior to the requested outage. Plan work so that duration of the interruptions a maximum of one day.

1.12 CONTROLS WIRING AND ELECTRICAL EQUIPMENT

A. All mechanical equipment controls wiring, conduit, relays, interlocks, and all accessories required for a completely operational controls system shall be the complete responsibility of the mechanical contractor. The mechanical contractor has the option to hire the project electrical contractor or any qualified controls contractor to install mechanical controls wiring and conduit. Refer to specification 251000 for installation requirements. Refer to Specification Section 253000 for coordination requirements between mechanical, electrical, and controls subcontractors.

B. Electrical items such as disconnect switches and motor starters associated with equipment provided by all Mechanical Divisions, when specifically mentioned to be furnished by the Mechanical Contractor, whether in these specifications or on the Electrical or Mechanical Drawings, shall be furnished by the Contractor. These items shall be mounted and connected as

required for a completely operational system. See Control Systems Specification for further information.

C. All electrical equipment characteristics (voltage, etc.) must be verified by the Contractor prior to ordering. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Architect/Engineer of the change and shall then coordinate the change with the Electrical Contractor and shall pay all additional charges in connection with the change.

D. All motors shall meet all the requirements of all Electrical Divisions.

1. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general-purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. All motors shall have copper windings. All motors to have minimum power factor of 85% or have switched correction to 90%. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40°C rise and total temperature rise of 65°C ambient and when powered from the system voltage feeding the motor. TEFC motors shall a service factor of 1.00 with total temperature is of 65°C in the above conditions. Motors located in areas exceeding 40°C ambient shall be factory-rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors. Single phase motors of 1/10 HP or less may be shaded pole induction motors.

1.13 PROTECTION AGAINST HAZARDOUS CONDITIONS

A. The Contractor shall take precautions against hazardous construction conditions at all times during construction. The final condition of the facilities shall be safe, and where safety to operating personnel is jeopardized, suitable signage shall be posted.

B. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operating personnel, shall be cut back and/or protected to reduce the risk of injury. All openings between floors shall be protected with barriers around the openings, gratings across the openings, or steel bars through the openings to avoid and protect against injury.

1.14 HAZARDOUS SIGNS

A. Equipment room contains moving or rotating parts, floor openings, or other potentially hazardous environments and shall include a sign on the door entering it that shall read similar to the following: **Hazardous Area - Authorized Personnel Only.**

1.15 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Mechanical Contractor shall furnish to the Owner a bound manual in triplicate, containing complete repair parts lists, and operating, service, and maintenance instructions on all mechanical equipment, fixtures, and systems.

B. The Mechanical Contractor shall also provide training as required by Section 230100 to the Owner's operation and maintenance personnel.

1.16 OPERATION PRIOR TO ACCEPTANCE

A. The Owner shall have the right to operate any and all apparatus as soon as and as long as it is in operating condition, after Owner personnel have received operational training, whether or not such apparatus has been accepted as complete and satisfactory, except that this shall not be construed to mean operations before any required alterations or repairs have been made. This operation does not indicate acceptance of the equipment by the Owner. When the Contractor enters into a contract with the Owner, he agrees to the above.

1.17 WARRANTY AND SERVICE PROGRAM

A. Due to the critical performance requirements and to clearly establish warranty responsibility for this project, the Contractor shall provide a full-service maintenance and warranty program to the Owner for one full year after beneficial occupancy (substantial completion).

B. This service program shall be included as part of the base bid and shall include service, maintenance, repair, replacement, lubrication, temperature control calibration and repairs, and documenting proof for all service and maintenance work on all equipment and system furnished by the Contractor.

C. A single representative in the employment of the Contractor shall be responsible for coordination and follow through of this program. This representative's name and phone number shall be submitted to the Owner as part of the maintenance manuals and supportive data. The Contractor shall respond to a request for service with 24 hours if so requested.

D. During this first year of operation, the following sequence of maintenance service shall be performed as a minimum.

1. Clean strainers in piping.

2. Fans and/or pumps be lubricated and oiled once every four (4) months.

3. Controls shall be calibrated throughout the facility at the end of six (6) months (following substantial completion). Any leaks in the piping systems shall be repaired.

4. All equipment manufacturer's service recommendations shall be followed during this period.

1.18 FLUSHING AND DRAINING

A. It shall be the responsibility of this Contractor to properly drain and flush all ducts and pipes before use or acceptance to ensure that all debris is completely removed. Damage caused by such debris remaining in the ducts or pipes shall be repaired by this Contractor at his expense. This Contractor shall demonstrate to the Architect/Engineer's representative that all piping is clean.

1.19 CLEANING

A. This Contractor shall remove from the building construction site all rubbish and dirt as it accumulates under the contract. At completion, all areas shall be broom cleaned and all obstructions, surplus materials, etc., removed.

1.20 GUARANTEE

A. The Contractor shall guarantee all materials, equipment, and workmanship furnished and installed by him under this Contract, to be free from all defects of workmanship and materials, and shall agree to replace at his expense, without expense to the Owner, at any time within one year after installation is accepted by the Architect/Engineer, any and all defective equipment, parts, etc., that may be found. (This excludes normal maintenance and daily servicing of equipment which is the Owner's responsibility.)

1.21 FLOOR, WALL, AND CEILING PLATES

A. Where exposed pipes pass through floors, finished walls, or finished ceiling, they shall be fitted with chromium-plated escutcheons of an approved pattern. Escutcheons and plates in Mechanical Rooms do not require chrome finish.

B. This Contractor shall be responsible for providing and installing all counter flashing. All openings in the roof shall be flashed and counterflashed. Use four-pound lead flashing materials for all vent lines and welded flashing in steel lines passing through roof. The Mechanical Contractor shall notify the General Contractor where each roof penetration is and the size of the opening.

1.22 PIPE SLEEVES

A. Schedule 40 steel pipe sleeves or pipe sleeves made of No. 20 gauge galvanized steel, properly secured in place with approximately 1/4" space between each sleeve and the surface of the pipe and/or insulation passing through it, shall be provided for all pipes passing through concrete floors, roofs, and masonry walls. All pipe sleeves shall be fixed in place as the walls and floors are built up. The Contractor shall furnish and locate all sleeves and pipes passing through concrete floors, exterior masonry walls, and roofs shall be made watertight with approved non-hardening plastic material. Sleeves through pipe chase or equipment room floors shall project a minimum of 2-inch above the floor and shall be of black steel pipe with waterproof flange at center of floor thickness. Each sleeve through a fireproof wall shall be packed with approved fireproof rope in the annular space.

1.23 PIPE HANGERS

A. Pipe hangers shall be Fee and Mason of a type suitable for each use. Perforated straps shall not be used in any work. For ferrous pipes up to and including 4 inch in size, use Fee and Mason Fig. 199 malleable iron, adjustable, split ring, swivel hanger. For plumbing piping larger than 4 inches, use Fee and Mason Fig 239 steel clevis hanger. Where several pipes are parallel at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on rollers where indicated on the Drawings. For copper pipes up to and including 3 inch in size, use Fee and Mason Fig. 360 malleable iron, copper plated hangers. For copper pipes larger than 3 inches, use Fee and Mason Fig. 364 copper plated clevis hanger.

B. Hanger rod sizes shall conform to the following schedule:

1. Pipe up to and including 2"	3/8" rods
2. Pipe 2-1/2", 3" and 3-1/2"	1/2" rods
3. Pipe 4" and 5"	5/8" rods
4. Pipe 6"	3/4" rods
5. Pipe 8", 10", and 12"	7/8" rods

C. Unless shown otherwise on the Plans, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following spacing:

1. Pipe up to and including 1-1/4"	8'
2. Pipe 1-1/2" and 2"	10'
3. Pipe 2-1/2" and 3"	12'
4. Pipe 3 1/2" and 4"	14'
5. Pipe 5" and 6"	16'
6. Pipe 8" and 10"	20'

D. Unless shown otherwise on the Plans, all horizontal runs of copper piping shall be suspended from the floor or roof construction as the case may be, by means of hangers with the following maximum spacing:

1. Pipe up to 3/4" in size	5'
2. Pipe 1" and 1-1/4"	6'
3. Pipe 1-1/2" and larger	10'

E. There shall be a hanger within 2 inches of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps at each floor. Vertical pipes within a space shall have not less than two supports.

F. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting, nor shall it be supported from equipment connection.

G. Expansion bolts shall be Ackerman-Johnson or Hilti.

H. Beam clamps suitable for use with this type of steel construction involved shall be Grinnell.

1.24 PRESSURE VESSEL CERTIFICATION

A. Not used.

1.25 ISOLATION

A. Excessive vibration or objectionable noise created in any part of the building by the operation of any equipment furnished and/or installed under the Mechanical Contract will be extremely objectionable and the Contractor shall take all precautions against the same by isolating the various items of equipment from the building structure and by such other means as may be necessary to eliminate all excessive vibration and objectionable noise produced by any equipment installed by them, and consequently, they shall design all foundations, supports, etc., for their equipment, and all piping with this end in view. In addition, these Contractors shall supervise the construction of all foundations and supports, whether they build them or not, in order that they may be constructed in such a manner as to prevent the transmission of objectionable noise and/or excessive vibration. Submit calculations on all vibration isolation equipment.

B. All equipment having moving parts shall be isolated from the building structure by means of Korfund isolation materials, unless specifically noted otherwise. All isolators shall be the same brand and shall be supplied from the same source. Equipment manufacturer's recommendations shall be followed in the isolation of equipment.

C. Vibration isolators shall have sufficient resilience to meet the following minimum efficiencies:

Motor HP	Equipment Room
Up to 5	90%
7-1/2 to 15	93%
20 to 40	95%
50 to 100	97.5%

D. Spring isolators shall be of the housed type with ribbed pads bonded to the underside of the baseplate or may be unhoused stable springs. Isolators shall be furnished with snubbers and limit stops where so recommended by the equipment manufacturer.

E. The Supplier of the isolating equipment shall, upon completion of the job, check all isolating materials and verify that they are installed properly, and submit a report in writing to the Architect/Engineer.

1.26 TESTING

A. Before completion of this project, the Mechanical Contractor shall test all materials and equipment which normally require testing. All piping, etc., shall be tested to meet code requirements or the Specification requirements, whichever is more stringent.

B. All equipment shall be operated sufficiently long enough to prove to the Architect/Engineer that the equipment performs satisfactorily and meets the requirements set forth on the Plans or in these Specifications.

1.27 CERTIFICATIONS

A. Before receiving final payment, the contractor shall verify that all equipment furnished, and all work done is in compliance with all applicable codes mentioned in these Specifications. Submit certifications and acceptable certificates to the Architect/Engineer.

1.28 GENERAL PIPING INSTALLATION REQUIREMENTS

A. Provisions for Drainage: All piping systems shall be installed so that they may be easily drained. Drain caps, plugs, or hose bibbs shall be installed at low points. Grade piping toward drain locations.

B. Alignment: All installed pipelines shall be straight and shall remain straight against strains. Proper allowance shall be made for expansion and contraction.

C. Clean as Installed: All piping shall be kept free from scale or loose dirt when installed and must be kept clean during the completion of the installation. All openings in the piping system shall be capped or plugged while awaiting further connections. All detergents, solvents and other cleaning agents shall be compatible with the materials of fabrication of the system in which they are used. They shall not adversely affect the materials of mechanisms in the systems and they shall be acceptable to equipment manufacturers. All detergents, solvents, and other cleaning agents shall also be compatible with the process streams to be handled by the systems in which they are used.

D. Insulated Fittings: Install between any dissimilar metals such as steel and copper.

E. Expansion and Contraction: The Contractor shall make all necessary provisions for expansion and contraction with proper fittings, anchors, dresser couplings, loops, etc. Install flexible connectors on each pipe at each building expansion joint.

F. Welding: Refer to Paragraph 1.29 of this section of these specifications.

G. Bending: No bending of pipe will be permitted.

H. General: The installation shall be coordinated with respect to space available with heating, cooling, ventilating, and electrical installation. In every instance where there is a conflict in the routing of the piping and the ducting, the routing of the ducting shall govern. Installed piping shall not interfere with the operation or accessibility of doors or windows, shall not encroach on aisles, passageways, and equipment, and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping, installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping above ground shall be run parallel with the lines of the building unless otherwise noted on the drawings. Unless otherwise shown on the drawings, horizontal piping shall pitch down in the direction of flow with grade of not less than 1 inch in 40 feet. Piping connections to equipment shall be in accordance with details shown on the drawings or as recommended by the equipment manufacturer. Service pipe valves and fittings shall be kept a sufficient distance from other work to permit finished covering not less than 1/2 inch from such other work, and not less than 1/2 inch between finished covering on the different services.

I. Installation of Valves: Valves shall be installed at the locations shown on the drawings and where specified and where directed at site. Gate valves shall be used unless otherwise shown, specified, or directed. All valves shall be installed with their stems horizontal or above. Where tight shutoff is required, a composition seat globe valve or resilient seat ball valve shall be used.

J. All valves which must be used during operation, all control valve assemblies, instrument control cases, liquid level controls, gage glasses, orifices, relief valves, and other equipment which must be observed, adjusted, or serviced during operation shall be located conveniently accessible from an operating platform or grade.

K. In general, relief valves within processing unit limits shall be located conveniently accessible from an operating platform or grade.

1. Those in non-hazardous service, such as water, shall discharge directly to outside.

2. Relief valves should have no piping between the vessel or line and the valve inlet, except as shown on the drawings.

3. Relief valves shall be installed in a vertical position. Vent piping shall be braced and supported in a manner that will not produce excessive stresses in the relief valve and will permit removal of the relief valve without necessary temporary supports for the vent lines.

L. Equipment Connections: All piping connections to pumps and other equipment shall be installed without strain at the pipe connection of the equipment. The contractor shall be required as directed to remove the bolts in flanged connections or disconnect piping to demonstrate that the piping has been so connected. Pipe connections to equipment shall be made with unions or flanged fittings. Provide removable headers for large equipment for service access.

M. Joints

1. Flanged Joints: All flanged joints shall be face matched. Raised face flanges shall not be mated to flat-faced cast-iron flanges on valves or equipment. The raised face must be turned off. All flanged bolt holes shall straddle the horizontal and vertical center line unless otherwise noted.

2. Screwed Joints: Screwed pipe joints shall have American Standard Taper Pipe Threads ANSI-B2.1 Latest Edition. Burrs formed when cutting pipe shall be removed by reaming. Care shall be taken that the inside of pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Joints shall be made perfectly tight by the use of Teflon tape or approved Teflon thread sealing and lubricating compound.

3. Solder-Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool or wire brush before seating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for serrated fittings on water, compressed air below 60 psig, and vacuum lines shall be made with a 95 percent tin and 5 percent antimony. Cored solder or solder containing lead will not be permitted.

N. Reducers: Reduction in pipe size shall be made with one piece reducing fittings. Bushings reducing at least two pipe sizes will be acceptable only when there is no room for reducing couplings or swaged nipples.

O. Unions: All piping unions shall be of the ground joint type constructed from materials equivalent in alloy composition and strength to other fittings specified with which they are used. Union Pressure classes and end connections shall be the same as the fittings used in the lines with the unions. Steel unions shall have hardened stainless steel seating surfaces on both faces.

1.29 WELDING

A. All welding of piping covered by this specification, regardless of condition of service shall be accompanied as follows:

1. The welding shall be in accordance with the recommendations of the American Welding Society. Mitering of pipe to form elbows, notching to form these, or any similar construction will not be permitted. Welding fittings shall be installed on all welded lines. Joints to be welded shall be properly aligned and spaced, using special welding clamps where necessary. All welders to be employed shall have passed qualification tests prescribed by the National Certified Pipe Welding bureau (or by another reputable testing laboratory or agency) using procedures approved by the American Society of Mechanical Engineers or the American Welding Society. The welders will be required to pass qualification tests when the work of the welder creates a reasonable doubt as to his proficiency. Tests shall be conducted at no additional expense to the Owner.

2. Each welder shall, in addition to having passed the prescribed qualification tests (as noted in Paragraph 1.30.A.1), prepare sample coupons at the job site on a portion of pipe that is cut such that the cross section of the weld is open to view. The sample weld should be prepared using a 6-inch diameter pipe. The sample shall reflect a continuous weld with perpendicular cut out to show the weld in cross sectional view. This sample, when accepted and approved by a certified welding inspector, shall be used as a standard of quality to compare to other welds that this welder will be performing on the job. This same sample weld will also be a basis for accepting or rejecting the welder for working on this project. The sample weld shall be identified with a date and the welder's name and shall be kept at the site throughout the project.

3. All welding on pressure piping shall conform to all of the requirements of the American Society of Mechanical Engineers Code for Pressure Piping - B31.1 (An American National Standards Institute publication), as defined in the latest edition of the ANSI Power Piping B31.1 Manual. All welding shall also conform to all of the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. All chapters, current addenda and supplements of these manuals shall apply. This code shall be used to establish standards of performance and quality of welds. However, the Owner reserves the right to perform radiographic testing of all welds, to compare any of the welds to the approved "standard" sample welds of each welder, and to compare the welds to the welding diagrams and sketches of those recommended in the ANSI B31.1 Power Piping Manual. The intent is to obtain the highest quality welding job possible. The cost of any initial radiographic testing, for random inspection, shall be paid for by the Owner. If radiographic random testing reveals that a weld is defective, the Contractor shall bear the cost of all repairs and re-testing necessary to be made to subject weld until conformance with radiographic tests is reached.

The potential for random radiographic testing and welding quality control applies to all pressure piping systems in this project, including systems below 100 psig. If a question should arise regarding the possibility of faulty welding or if there are obvious visual defects in the welding, the Contractor shall be required to correct such deficiencies to a quality level consistent with the recommendations, welding diagrams and sketches in the ANSI B31.1 Manual. The quality level shall also reflect that of the approved sample welds accomplished by each welder for this particular project.

1.30 TESTING FOR PIPING SYSTEMS

A. General: Before insulation is applied, all piping, equipment, and accessories installed under this contract shall be inspected and tested by the Contractor. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying tests. Prior to performing tests, all lines shall be "blown" free of all loose dirt and foreign particles. The lines shall then be thoroughly flushed with water (liquid lines only) at a sufficient flow rate and period of time, to ensure complete cleaning of the lines of all dirt, scale, and foreign matter. Satisfactory flushing of the lines shall be subject to approval. After testing and flushing lines, all filters and strainers shall be cleaned.

B. Safety: Since the Risk of failure, with the attendant possibility of injury, is appreciable greater with further testing, all safety measures required by codes or ordinance or reasonable applicable to the situation shall be taken.

C. Concealment: Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Compression joint underground piping may be backfilled prior to pressure test except that joints shall remain exposed until after the test, but tie rods, clamps, etc., shall be in place and fastened.

D. Pressure Ratings: These tests shall not be used to establish pressure ratings.

E. System Protection: Protect all piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during the filling, testing, and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating. Note that where significant differences in elevation exists, there is a risk of overpressure in the lower portions of the system in order to attain test pressure in the upper portion of the system.

F. Test Temperature: Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes require testing above a specified minimum temperature.

G. Sectionalizing: Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

H. Temporary Supports: During hydrostatic testing of lines provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

I. Testing: Fire protection water piping shall be tested hydrostatically at the test pressures specified and duration required by NFPA. Leaks shall be located by soap testing.

J. Sanitary Waste and Soil System:

1. After all soil and waste pipes and vent stacks have been installed, the outlets shall be plugged, and the piping system filled with water in vertical sections to the highest point of the system and allowed to remain filled for twenty-four (24) hours and shall prove to be leaktight under such conditions. A one-inch drop will be allowed in water level in standpipe. This test may be conducted in segments as required by the sequence of construction. Contractor shall certify in writing that all tests were satisfactorily completed before piping was concealed and shall submit the certification to the Architect/Engineer for his records and for transmittal to the owner.

K. Test Report

1. A detailed report of pressure tests on piping and equipment shall be forwarded in duplicate to the Architect/Engineer. This report shall show date of test, lines tested, test medium, length of time test pressure was held, pressure drop or rise, and extent of venting or repressurizing.

1.31 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other sections of these specifications covering the work of other trades which must be carried out in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination.

1.32 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions covering the mechanical work at the building. No extra compensation shall be claimed or allowed on account of difference between actual dimensions and those indicated on the drawings. He shall examine the adjoining work on which Mechanical work is dependent for maximum efficiency and shall report any work which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable work conditions affecting Mechanical work.

1.33 SAFETY GUARDS

A. The Mechanical Contractor shall furnish and install safety guards required in order to obtain certificates of inspection from all authorities having jurisdiction. All belt driven equipment, projecting shafts, and other rotating parts shall be enclosed or adequately guarded. Provide coupling guards on all rotating shafts.

1.34 PROTECTION

A. All work, equipment, and materials shall be protected at all times to prevent obstruction, damage, or breakage. All pipe openings shall be closed with caps or plugs during installation. All equipment shall be covered and protected against dirt, water, chemical, or mechanical injury. At the completion of the work, all equipment shall be thoroughly cleaned, and the entire system shall be delivered in a perfect, unblemished condition.

1.35 PAINTING AND IDENTIFICATION

A. All equipment shall be delivered to the job with suitable factory finish. Should the finish be marred in transit or during installation, it shall be finished to present a neat, workmanlike appearance.

B. Except as elsewhere hereinafter specifically required, any painting of equipment, piping, ductwork, grilles, insulation, etc., furnished and installed under this Section of the Specifications will be done by the Painting Contractor. However, the Mechanical Contractor shall leave his equipment clean and free from any grease, dirt, rust, etc., and in suitable condition for painting.

C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.

D. The piping shall be painted the basic color as indicated in other sections of these specifications and shall be marked every 10 feet on centers with Brady pipe markers. Arrows, approximately 6 inch in length and spaced about 10 feet on centers shall indicate the direction of the flow pipe. Locate additional labels as required in Mechanical Rooms. Staple in place, brush with clear lacquer. Markers shall state pipe size, flow direction, and pipe usage (such as "cold water," etc.).

1.36 RECORD DRAWINGS

A. The Contractor shall, during the execution of the work, maintain a complete set of drawings upon which all dimensional locations of equipment piping and all deviations and/or changes in the work shall be recorded. Water, storm, and drainage mains shall be delivered to the Architect/Engineer in good condition upon the completion and acceptance of the work and before final payment is made.

1.37 SUPPLIER RESPONSIBILITY

A. Each supplier, whether furnishing equipment as specified or as a substitution shall be responsible for certifying that the equipment is properly installed and that the warranty is valid. Submit written reports on the installation and the equipment performance when requested to do so by the Architect/Engineer (or his representative). Each supplier shall be responsible for furnishing qualified personnel at the job site at anytime requested by the Architect/Engineer (or his representative) during the construction or warranty periods.

END OF SECTION 21 05 00

SECTION 21 13 00 - AUTOMATIC SPRINKLER SYSTEMS

PART 1 – GENERAL

1.1 WORK INCLUDED

A. This specification, in conjunction with the contract drawings and all other specifications indicate materials and operations required for the installation of automatic sprinkler systems, including design, shop drawings, equipment, underground supply system, pipe and fittings above ground, fire department connections, sprinkler systems, guard rail, operating instructions, identification, tests, and sterilization of piping and system.

B. Any variation of the specification's intent or apparent conflict from this specification shall be submitted to the ARCHITECT/ENGINEER for written response. The response shall be incorporated into the drawings and shall be the final word on the item. The Contractor shall incorporate any change at no charge to the Owner.

1.2 REFERENCES

A. This specification section is not limited to the following specification:

210000	FIRE SUPPRESSION INDEX
210500	GENERAL FIRE SUPPRESSION REQUIREMENTS
221000	PIPE AND PIPE FITTINGS

B. The current editions of the following standards are a part of this specification.

1. National Fire Protection Association (NFPA) Standards.

a) 13 Standard for the Installation of Sprinkler Systems.

b) 14 Standard for the Installation of Standpipes and Hose Systems.

c) 24 Private Fire Service Mains.

d) 70 National Electrical Code.

e) 72 National Fire Alarm Code.

f) 25 Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems.

2. American Water Works Association Standard Specifications.

a) C600 Standard for the Installation of Ductile-Iron Water Mains and Their Appurtenances.

b) C151 Ductile-Iron Pipe

c) C110 Ductile-Iron and Gray Iron Fittings.

d) C111 Rubber Gasket Joints for Ductile-Iron and Gray IronPressure Pipe and Fittings.

e) C104 Cement-Mortar Lining for Ductile-Iron and Gray Iron Pipe and Fittings.

f) C500 Metal Seated Gate Valves for Water Supply Service.

g) C601 Standard for Disinfecting Water Mains.

C. Underwriters' Laboratories, Inc. (UL), Publication: Fire Protection Equipment List.

D. Factory Mutual System Publication: Approval Guide.

E. American Insurance Association Publication: Internal cleaning of sprinkler piping (GP-4).

1.3 SYSTEM DESCRIPTION

A. Design

1. The designer of the fire protection systems shall meet one of the requirements below.

a) A registered Professional Fire Protection Engineer in the State of New Mexico.

b) Minimum National Institute for Certification in Engineering Technologies (NICET) Level III for wet-pipe or dry-pipe, Ordinary Hazard, Group II Sprinkler Systems, regardless of size.

c) Minimum NICET Level IV for all other types of systems, including special hazard protection.

d) Where NICET design is used, copies of the designer’s certificates from NICET shall be submitted along with the drawings for approval. The registered Professional Engineer shall stamp all other plans.

2. The contractor is responsible for the design and installation of the fire protection system in accordance with these specifications and the contract drawings. The Contractor shall coordinate with architectural, civil, mechanical, and electrical, design and construction documents, to ascertain the required information, to affect a properly designed fire protection system for the building construction and occupancy classification.

a) The contractor is responsible to design the automatic sprinkler system in accordance with these specifications and the contract drawings. The contractor shall refer to all architectural, mechanical, and electrical drawings, to ascertain the required information, to affect a properly designed sprinkler system for the building construction and occupancy classification.

3. The design of fire protection systems shall be complete with all necessary accessories for proper operation and shall include seismic support details.

4. The fire protection water supply lines, controlling devices, protective devices, alarm systems, supervisory devices, and related equipment shall be compatible so that all equipment will function together as specified.

5. The design shall comply with all mandatory, advisory interpretations, and recommended applicable rules of the latest editions of the referenced codes and standards in Section 1.3, "References," except where otherwise noted on the drawings or specified herein.

6. The Contractor shall produce design drawings that indicate the extent and arrangement of the fire protection system.

7. The contract drawings indicate the extent and general arrangement of the automatic sprinkler systems.

B. Spacing and Pipe Sizing

1. Unless otherwise specified or shown on the drawings, the sprinkler system shall be a wet pipe system, utilizing a Light Hazard hydraulic design.

2. Hydraulically system shall be designed on the contract drawings having the following characteristics:

a) The design area shall be the hydraulically most demanding "rectangular area" having a dimension parallel to the branch lines equal to 1.4 times the square root of the area of sprinkler operation.

b) Where the design area includes a corridor or tunnel protected by a single row of sprinklers, the maximum number of sprinklers that need be calculated is 10, unless openings into the corridor are unprotected by fire rated construction.

c) Maximum water flow velocity shall not exceed 20 feet per second in any sprinkler system piping of hydraulically designed systems.

d) The hose allowance shall be added to the sprinkler requirement at the point(s) where the hose station(s) connect(s) to the sprinkler system. The selected hose station(s) shall be within or nearest to the area of sprinkler application.

e) Hydraulic design shall be based upon the water supply data shown on the drawings or obtained from the local Municipal Water Department.

f) Pipe schedule method shall be permitted only for additions or modifications (less than 3000 feet^2 to existing Ordinary Hazard Pipe Schedule systems. All other designs shall be hydraulically calculated.

g) Hydraulic calculation methods shall be used as a minimum for Light Hazard, wet-pipe systems, unless otherwise specified. The minimum operating area allowed shall be either 1500 feet^2 or the entire area for smaller systems. No allowances or reductions shall be permitted without written approval from the ARCHITECT/ENGINEER.

h) Extend all (regardless of job size, and including modifications, new installations, retrofits, recalculations, etc.) hydraulic calculations back to the effective point of connection (ring-main) of the sprinkler lead-in to the fire water main supplying the building, unless indicated on the contract drawings.

i) The distance between sprinklers either on branch lines or between branch lines shall not be less than 6 feet distance apart.

C. Seismic Protection

1. Seismic protection for automatic sprinkler systems is required for all new systems. Modifications to existing systems shall require seismic protection when indicated on the contract drawings.

a) For modifications to existing systems, seismic protection will be required for only that portion of the system being modified, the feed main supplying the modification area, and the riser for that area.

b) Seismic separation joints are required in areas separating the modified area of the sprinkler system and that area which is not to be upgraded for seismic protection.

c) The installation guidelines for seismic protection in NFPA 13 shall be used. Where an alternative method (other than NFPA 13) of providing seismic protection of a sprinkler system is to be used, only UL Listed or FM Approved material shall be permitted. The alternative method shall have a design based on a dynamic seismic analysis certified by a registered Professional Engineer in the State of New Mexico and the registered PE shall stamp all drawings.

D. Standpipes

1. Standpipes, where shown on the drawings, shall be installed as Class I system per NFPA 14. Hydraulic calculations are required for all wet standpipes serving two or more hose stations.

E. Protection of Areas Subject to Freezing

1. All anti-freeze systems require the installation of a reduced pressure backflow prevention (RPBFP) device. If a RPBFP is installed on the entire sprinkler system, then no additional RPBFP is required for the anti-freeze system.

2. Gridded or looped dry pipe or pre-action systems are not allowed. The design for these systems shall be of the conventional tree design.

3. All dry-pipe systems, regardless of the volume, are required to deliver sustained waterflow to the inspector's test connection within 60 seconds of the opening of the inspector's test valve. All dry pipe systems in excess of 500 gallons shall be provided with a UL listed or FM approved quick opening device, exceptions to NFPA 13 in this instance do not apply.

F. Manifolding of sprinkler risers to one single sprinkler lead-in shall not be permitted.

G. Fire Department connections shall be as follows:

1. Install Fire Department connections, where shown on the drawings.

2. When the sprinkler system hydraulic demand (not including exterior hose demand) exceeds 1000 gpm, a 6-inch 3-way Fire Department connection shall be provided.

3. A single fire department connection shall be provided to supply all fire protection systems for a building that has greater than 5 sprinkler risers.

H. Exposure protection design shall be as follows:

1. A minimum of 3 gpm per linear feet using ½-inch orifice sprinklers spaced a maximum of 10 feet apart horizontally apart shall be calculated. Sprinklers shall be high-temperature rated.

2. The vertical distance protected by a single line of sprinklers shall not exceed 15 feet. A single line of sprinklers may protect a single-story building that has a 20 feet maximum height. All heights exceeding this will require more than one row of sprinklers vertically.

3. Hydraulic calculations shall include all of the sprinklers facing the exposure, on every row.

I. Elevator Shafts and Machine Rooms

1. Sprinklers are required at the tops of all elevator shafts and in the elevator equipment rooms. Sprinklers shall be protected from freezing.

2. Provide an OS&Y gate valve to shut off all sprinkler water flow into the elevator shaft and into the elevator machine room. Where possible, piping should be arranged such that a single valve can shut off water to both locations.

3. The valve(s) shall be at a readily accessible location, no more than 7’0” above finished floor, inside a clearly marked wall cabinet.

1.4 SUBMITTALS

A. Shop Drawing Submittals

1. Provide as required by Division 1, Descriptive Submittals, to the ARCHITECT/ENGINEER.

2. As soon as practicable after award of contract and prior to fabrication, contractor shall submit to the ARCHITECT/ENGINEER for approval, complete shop drawings, manufacturers' catalog data, system and component operating instructions and hydraulic calculations for the sprinkler system and underground piping shown on plot plans.

3. NO INSTALLATION WILL BE PERMITTED prior to the ARCHITECT/ENGINEER approval of complete shop drawings.

B. Presentation:

1. New Sprinkler Systems

a) New drawings shall be identical in size, scale, orientation, and title as the original building construction contract drawings unless otherwise noted.

C. Drawing Details

1. Unless otherwise specified or shown on drawings, new floor plans and full height cross sections shall be drawn at a scale of 1/4" = 1'-0" and arranged such that the north arrow points to the top or to the left of the sheet. Other details shall be drawn to a larger scale, as required. Riser elevation details shall be drawn to a scale of 1/2" = 1'-0".

2. No more than one building or one floor shall be shown on a sheet.

3. Drawings shall show all details required and recommended by NFPA 13, for "Working Plans" in addition to the following:

a) A name or room number shall appear in each room; and a scaled key plan, oriented the same as the floor plan, shall appear on each partial plan sheet.

b) All obstructions to the sprinkler layout shall be shown, including but not limited to, HVAC ducts, lighting, electrical buss ducts.

c) Building column lines shall be labeled.

d) Existing work and new construction shall be clearly differentiated on the drawings (where applicable).

e) All lines and details shall be drawn; "opposite hand" or mirror image IS NOT acceptable -- separate drawings shall be made.

f) All pipe lengths shall be shown, center-to-center of fittings.

g) Where more than one type of pipe is used, each piece of pipe shall be identified as to type on the drawings.

h) The drawings shall be kept neat and well arranged, with legible notes and figures to permit photographic reduction to one half size or smaller.

i) No lettering shall be smaller than 1/8 inch.

D. Plot Plans

1. Plot plans shall be drawn to 1" = 20'-0" unless otherwise shown on the contract drawings.

2. Previous references to orientation, legibility, and lettering shall apply.

3. Plot plans shall show all details required by NFPA 13 and 24.

E. As-Built Drawings

1. Upon completion of the work, the Contractor shall revise all drawings to agree with the construction as actually accomplished. The notation "As-Built" shall be entered in the revision block, dated, and initialed.

2. The As-Built drawings shall show the entire sprinkler system as it existed at the completion of the contract work.

3. The original As-Built drawings shall be delivered as directed by the ARCHITECT/ENGINEER.

1.5 ALTERNATES/ALTERNATIVES

A. Where specific manufacturers or model numbers are mentioned in these specifications, proposed substitutions shall be included in the submittal package furnished to the ARCHITECT/ENGINEER for approval after contract award.

B. If UL-listed or FM-approved equipment is commercially available, none other will be approved.

1.6 WARRANTY

A. All sprinkler system components furnished under this contract shall be guaranteed against defective design, materials, and workmanship for the full warranty time, which is standard with the manufacturer and/or supplier, but in no case less than one year from the date of system acceptance.

PART 2 – PRODUCTS

2.1 MATERIALS, GENERAL

A. Materials and equipment used in the installation of the sprinkler system shall be new and listed by the UL Fire Protection Equipment Directory or the FM Approval Guide, latest edition. The standard products and the latest design of the manufacturer shall be used, and installed per their listing, approval, or manufacturer recommendations. All products listed or approved by prior editions of the UL Director of FM Approval Guide will not be acceptable, if not listed or approved in the most recent edition of the directory or approval guide.

B. Where two or more units of the same class of equipment are required, these units shall be products of the same manufacturer (e.g., couplings shall be from one manufacturer.) All materials shall be installed per their listing or approval and per the manufacturer’s recommendations and specifications.

C. New dry pipe, pre-action and deluge sprinkler systems shall be provided with the following devices:

1. A FM approved or UL listed air dryer for the sprinkler control air supply for dry-pipe and pre-action systems.

2. A FM approved or UL listed air dryer for the air supply to any pneumatic tubing used for heat detection (if used).

3. Where air compressors are used, the air compressor will come equipped with a minimum 10-gallon tank. Nitrogen bottles are permitted to supply nitrogen pressure to systems smaller than 125 gallons in size. Where the system capacity is larger than 125 gallons, air compressors shall be used.

D. Tape for screwed joints shall be minimum ½-inch wide.

E. Corrosion protection tape shall be Scotchwrap 51, manufactured by 3M Company or approved equivalent.

2.2 SPRINKLERS

A. Types

1. Unless otherwise specified, allowed per other section of this document, or shown on the drawings, sprinklers shall be nominal, ½-inch orifice, automatic, closed-head sprinklers rated at 155ºF (68ºC) Quick Response, frangible bulb type fusible element.

2. Higher temperature rated sprinklers shall be installed where heads are exposed to high ambient temperature, exposed to the direct rays of the sun, beneath skylights or windows and installed in the vicinity of heating equipment, or in attics. The sprinkler temperature chosen shall be a minimum of 50ºF above the maximum ambient temperature, and no greater than 100ºF above the ambient conditions, unless specifically directed by NFPA 13.

3. Rooms containing electrical equipment shall be protected with sprinklers having the following minimum temperature ratings, but no less than 50ºF above normal ambient room temperature:

a) Transformer and Switchgear rooms; Elevator machine rooms	212ºF (100ºC)
b) Computer rooms	155ºF (68ºC) QR
c) Telephone equipment rooms	155ºF (68ºC) QR
d) Top of elevator shafts	212ºF (100ºC)

4. On-Off sprinklers are not allowed. FM approved or UL listed on-off sprinkler systems, like the Viking FireCycle (or approved equal), are allowed.

5. Quick Response (QR) sprinklers, where specified on the drawings, shall have a Response Time Index (RTI) of 50 or less in English units and 28 or less in metric units.

6. Sidewall sprinklers shall be Underwriters' Laboratories listed or Factory Mutual approved for Ordinary Hazard Occupancy.

7. Extended coverage sprinklers are not allowed.

8. Only sprinklers with a “Belleville” type seal shall be used. No O-Ring sealed sprinklers shall be allowed either in “crush” seals or “radial” seal styles. Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism.

9. Only sprinklers with integral shields listed by UL as “intermediate level” sprinklers or by FM as “racked storage” sprinklers are acceptable indoor where shield are required over ordinary sprinklers. Shop-made water shields are not allowed, nor are after market attachments designed as water shields. “Heat collection devices” for use with sprinklers shall not be allowed.

10. Sprinklers installed in storage racks shall be equipped with a listed sprinkler head guard with an integral water shield to protect the in-rack sprinklers fusible element from water spray by a sprinkler above it. Roof sprinklers subject to mechanical damage shall be equipped with a listed sprinkler head guard.

B. Protection Against Freezing

1. Horizontal dry sidewall sprinklers shall be used in lieu of antifreeze loops for narrow unheated areas adjacent to heated areas, such as docks, covered loading platforms, vehicular air locks, elevator hoistways, and gas bottle or other storage sheds.

2. The depth of the protected space shall not exceed 10 feet.

3. The dry sprinkler shall extend a minimum of 12 inches into the heated space. For refrigerated spaces, the length dry sprinklers shall extend into the heated space shall be as specified by the ARCHITECT/ENGINEER.

C. Position and Finish

1. Sprinklers installed on exposed piping shall be manufacturer’s standard finish pendent sprinklers. Sprinklers and escutcheons installed below dropped ceilings shall have a finish matching the color of the ceiling tile. Only factory applied finishes shall be acceptable. If the factory has a finish that cannot match the ceiling tile color, standard finish sprinklers are allowed.

2. In rooms where sprinkler heads penetrate a suspended ceiling, only quick response, semi-recessed or recessed sprinklers are acceptable. Standard pendant sprinklers with “cup and skirt” escutcheons, one-piece escutcheons, or flush or concealed sprinklers are not allowed.

3. EXCEPTION: On existing installations only, where sprinkler head relocations or small modifications (less than 20 heads) take place, the new sprinklers and escutcheons shall match the existing sprinklers.

4. Escutcheons, head guards, and water shield from the supplied sprinkler manufacturer shall be used solely with the installed sprinkler. No aftermarket escutcheons, head guards, or water shields are allowed.

5. Head guards shall be two-piece, universal attachments, bolted in place on the sprinkler. “Snap-on” one-piece units are not allowed.

2.3 PIPE

A. Pipe for installation above ground shall be metal conforming to the requirements of NFPA 13. No plastic pipe is permitted in any location whether or not permitted by NFPA. Pipe shall be listed by UL and be FM approved, and installed per its listing and approval and meet the following requirements:

1. Mechanical rolled groove pipe or cut groove pipe shall not be used at fire protection risers or for segmented arcs. Use swing jolt at locations of segmented arcs.

2. Unless otherwise specified, the minimum steel pipe wall thickness shall be Schedule 10 for pipe sizes 3 inches or larger. Pipe sizes smaller than 3 inches shall be Schedule 40. Threaded or cut groove steel pipe shall be Schedule 40 for sizes less than 8 inches and a minimum of Schedule 30 in sizes 8 inches and larger for pressures up to 300 psi.

3. Mechanical rolled groove pipe or welded pipe shall be a minimum of Schedule 10 for sizes 3 inches up to 5 inches, 0.134-inch wall thickness for 6 inches, and 0.188-inch wall thickness for 8- and 10-inch pipe for pressures up to 300-psi.

4. Steel pipe, installed for the water motor alarm line, piping from drain line valves and inspector's test valves, dry pipe, and pre-action sprinkler system piping, and where pipe is exposed to outdoor weather, etc., shall be internally and externally galvanized. Galvanized fittings are required where galvanized piping is used. Any piping leading to a pressure-operated waterflow indication device shall also be galvanized. The starting point is on the alarm connection to the alarm check valve.

B. Mechanical rolled groove pipe or cut groove pipe shall not be used at fire protection risers or for segmented arcs. Use swing jolt at locations of segmented arcs.

2.4 PIPE FITTINGS

A. Pipefittings for installation above ground shall conform to the requirements of NFPA 13 and shall be FM approved or UL listed.

1. Mechanical groove couplings are required on all 4 inches and larger pipe.

2. Plain-end pipe couplings shall not be used in any new installation.

3. Galvanized pipefittings shall be installed where galvanized piping is specified.

4. Welded branch outlet fittings (weld-o-lets, groove-o-lets, etc) shall be minimum Schedule 10 for pipe sizes 3 inches or larger. Pipe sizes smaller than 3 inches shall be Schedule 40 standard wall pipe thickness. Welded outlets shall be UL listed or FM approved, affixed with the UL or FM identification stamps, and pressure rated for 300-PSI maximum.

5. Adjustable, two-piece drop nipples shall not be used. All drop nipples shall be one-piece, non-adjustable units with a minimum 1-inch diameter.

2.5 PIPE HANGERS, SUPPORTS AND SEISMIC BRACING

A. Pipe hangers, and hangar assemblies shall be UL listed of FM approved.

B. C-clamps and beam clamps shall have lock nuts and retaining straps, or clips, and pipe rings shall be of the solid-band adjustable swivel type.

C. Provide rod-ceiling plates at finished ceilings for coach screw rods, expansion shields, and toggle hangers.

D. All seismic bracing devices and flexible couplings shall be specifically UL listed or FM approved and installed per their listing or approval.

E. When fastening hangars to purlins, bolt-through fastening methods shall be used. Beam clamps with restraining straps shall not be used in any circumstance.

F. All seismic brace members shall be continuous. Under no circumstances shall members be spliced or offset.

G. Tension-only seismic bracing systems shall meet the following.

1. The tension-only system shall be UL or FM approved for seismic service and installed in accordance with listing limitations and installation instructions.

2. A means to prevent vertical motion due to seismic forces shall be installed at the brace location.

3. Two tension only braces shall be installed in opposing directions at each brace location.

2.6 FIRE PROTECTION CHECK VALVES

A. Check valves in sprinkler system shall be UL listed or FM approved, have hand hole covers to provide adequate access to facilitate inspection and repair, without the removal of the valve from the system, and shall be listed for installation in the vertical or horizontal position. Wafer check valves are unacceptable. All check valves shall have a working water pressure of 250 PSI.

B. Alarm check valves (wet pipe, dry pipe, deluge, pre-action, etc.) shall be provided on all sprinkler risers and have the following.

1. The alarm check valve (ACV) shall be equipped with a removable hand hole cover assembly and shall be listed for installation in the vertical or horizontal position.

2. The ACV shall be equipped with gauge connections on the system side and supply side of the valve clapper.

3. ACV trim piping and fittings shall be internally and externally galvanized.

4. Ported alarm connections on the ACV shall be to a retard chamber to absorb variable pressure surges.

5. Only “Flange x Flange” ACV devices shall be installed.

6. Wet-pipe systems shall use a variable-pressure alarm check valve. Plain-type check valves are not allowed. Sprinkler alarm valve shall be equipped with an external bypass to eliminate false water flow alarms.

7. Dry-pipe valves shall be a positive latching clapper, differential type dry valve and air pressure to water pressure area differential shall be approximately 5 to 1.

8. Deluge valves shall be externally re-settable by hydraulic means and shall employ a positive vent on the priming line to ensure that the deluge valve will not prematurely reset.

C. Backflow prevention devices shall be installed on all sprinkler systems as follows.

1. A reduced pressure backflow prevention assembly (RPBFP) shall be installed to prevent cross-connection contamination between potable water systems and any fire sprinkler system, at the service connection for the fire sprinkler system.

2.7 FIRE PROTECTION INTERIOR CONTROL VALVES

A. Each system shall have interior control valves as follows:

1. A control valve shall be installed for isolation of each floor of multistory buildings.

2. Interstitial spaces, in-rack sprinkler systems, mezzanines, etc., shall have control valves for system isolation at the feed-main.

3. All control valves shall be provided with an electric valve supervision device, connected to the Fire Alarm System.

4. All inside control valves shall be OS&Y. Butterfly valves are not permitted. Valves shall be manufactured in accordance with AWWA Standard C500 and have a clear waterway equal to the full nominal diameter of the valve. Valves shall be provided with a handwheel, with arrow cast in metal to indicate direction of opening.

2.8 SUPERVISORY DEVICES

A. When specified on the contract drawings, supervisory devices shall be compatible with the Fire Alarm System.

B. Provide the equipment listed below.

1. Electric valve supervision switches shall be installed for all internal (inside) and external (outside) fire protection valves 2-1/2 inches or larger. The devices shall be electrical; single-pole, double-throw; with normally closed contacts and include design that signals controlled valve is in other than fully open position.

2. For wet pipe sprinkler systems, install vane-type waterflow alarm initiation devices with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-

pole, double-throw, circuit switches for isolated alarm and auxiliary contacts and complete with tamperproof cover that sends signal if removed.

3. All vane type waterflow alarm initiation devices shall be equipped with an adjustable delay of audible alarm initiation. Adjustment range shall be from 0 to 120 seconds. Vane type waterflow switch shall be Potter Model VSR-F or approved equal.

4. Waterflow vane-type alarm initiation devices shall be labeled as to the correct orientation of flow when mounted on system piping. When drilling of the system riser it is necessary to mount flow switch, the drilled-out disc (coupon) shall be retrieved and attached to the mounting u-bolt of the flow switch.

5. Where pressure operated waterflow alarm initiation devices are used, any valve installed upstream of the device on the alarm line shall be electrically supervised, using the Potter Model BVS or approved equal. Pressure operated alarm initiation devices shall be an electrical-supervision type, waterflow switch with retard feature. The device shall include single-pole, double-throw, normally closed contacts, and design that operate on rising pressure and signals waterflow.

    a) EXCEPTION: Where the waterflow alarm initiation device is used only for the purpose of an outside electric bell in lieu of the water motor gong device.

6. Low-pressure supervision shall be installed on all dry pipe or pre-action systems and be connected into the Fire Alarm System.

7. Any device that is to be installed in a hazardous location defined by NFPA 70 shall be rated for occupancy.

2.9 FIRE DEPARTMENT CONNECTIONS

A. Fire Department connections shall have a minimum of two 2-1/2-inch inlets with National Standard Hose (NWSH) threads, internal double clapper check valve, brass plugs, and attached chains.

B. Fire Department connections shall be installed at each new alarm check valve, dry pipe valve, deluge and pre-action valve and standpipe, unless the sprinkler system is supplied by a Fire Department connection in the yard main, or as otherwise noted in NFPA 13.

C. The completed installations shall include a metal sign or escutcheon plate, with raised lettering, marked “FIRE DEPARTMENT CONNECTION STANDPIPE-AUTO S0KR,” ‘AUTOMATIC SPKR,” or “STANDPIPE,” as appropriate. Additional signs for systems such as foam water sprinkler systems or other alternative designed systems, as required by other NFPA Standards, shall also be provided by the Contractor where required.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Responsibilities

1. The Contractor is responsible for the installation of the automatic sprinkler system in accordance with these specifications and the contract drawings. The Contractor shall coordinate with architectural, mechanical, and electrical, design and construction documents, to ascertain the required information, to affect a properly designed and installed sprinkler system for the building construction and occupancy classification.

2. The installation of the automatic sprinkler system shall be complete with all necessary accessories for proper operation and shall be accomplished by a licensed sprinkler contractor or licensed company regularly engaged in this type of work, and in accordance with requirements of the National Fire Protection Association Standards (NFPA).

3. An individual with a minimum NICET Level II shall supervise the installation.

4. The fire protection system installation shall be coordinated with the other trades (mechanical, electrical, and structural, etc.).

5. The installation shall comply with all mandatory, advisory interpretations, and recommended applicable rules of the latest editions of the standards listed in Section 1.3 of this document, except where otherwise noted on the drawings or specified herein.

B. Contamination and Obstruction Prevention

1. Pipe interiors shall be kept free of debris.

C. Pipe and Fittings Aboveground

1. Pipe, fittings, and hangers shall be installed where shown on the drawings and in accordance with the requirements of NFPA 13.

2. Overhead sprinkler piping, drain and test piping, fire department connection piping, etc. installed through exterior walls shall be galvanized. All sprinkler piping shall be substantially supported from building structure and only UL listed, or FM approved type hangers shall be used. Sprinkler lines under ducts shall not be supported from ductwork but shall be supported from building structure (with trapeze hangers where necessary).

3. Flanged Fittings or Mechanical Groove Couplings

a) Flanged fittings or mechanical groove couplings shall be used at the base of risers, in the risers of multiple-story sprinkler systems at each floor-system connection, and in feed main. Flanged fitting shall be used for alarm valve assemblies.

b) A flanged tapered reducer shall be installed at the flange and spigot piece when riser is smaller than the underground supply line.

c) Pipe shall be installed straight and true with no greater deflection at mechanical groove pipe couplings than is recommended by the manufacturer.

d) Pipe end couplings are not acceptable.

e) Only rigid-type mechanical couplings shall be used, unless specifically directed by NFPA 13 such as for specific seismic locations. Only in those areas identified by NFPA 13 where flexible type mechanical couplings are specified will the use of flexible couplings be permitted. All other parts of the system shall use rigid-type mechanical groove couplings.

4. Pipe Hangers and Anchors

a) Hanger rods for all equipment, pipes, ducts, trapezes, vibration isolators, etc., shall be installed straight, true, and plumb. Do not bend or flex hanger rods to accommodate sloping structures, avoid obstacles, or for any other purpose. Where necessary, utilize swivel beam clamps, beveled or swivel hardware, angled, swivel or hinged brackets spanning members or other appropriate means of connection.

b) Offsets in hanger rods will not be permitted.

c) Concrete anchors shall be installed by drilling and installing a UL listed or FM approved anchor. Explosive driven fasteners as a method of installing anchors or hangers shall not be permitted.

d) Supports, hangers, braces, etc., shall be attached to the building primary structural members only.

e) When fastening hangers or braces to bar joists, the fastener shall be located within 4 inches of the panel point on the bar joist.

f) All piping larger than 4 inches in diameter shall be supported from a minimum of two-bar joists when run parallel to a bar joist.

5. Welded Joints

a) Welded joints are acceptable when shop fabricated in conformance to provisions of NFPA 13.

6. Screwed Joints

a) Teflon paste and tape shall be used as pipe-joint compound at screwed joints.

7. Bushings

a) Bushings shall not be permitted.

8. Control Valves

    a) Control valves shall be provided with identification signs describing the areas protected. Where the valve location is concealed above the ceiling, a sign below the ceiling shall indicate the valve location and identify the protected area.

9. Wall, Ceiling, and Floor Penetrations

    a) Pipe sleeves shall be installed and properly secured in place at all points where sprinkler piping passes through concrete or masonry construction. Sleeves through all walls and floors shall provide adequate clearance for slight movement of the piping. The guidance in NFPA 13 guidance for seismic areas shall be followed.

    b) Sleeves for pipes passing through floors of concrete or waterproof construction shall project 3 to 6 inches above floors to prevent leakage. Sleeves through walls shall be cut flush with each surface unless otherwise specified. Sleeves shall be caulked to make penetration watertight.

    c) Unless otherwise specified, sleeves shall be of Schedule 40 steel and a minimum of two pipe sizes larger in diameter than the passing pipe.

    d) Holes through walls, floors, and ceilings of other than concrete or masonry construction shall be large enough to accommodate pipe expansion. Holes through existing concrete floors and walls shall be core drilled to provide clean, neat holes. Spaces between pipe and sleeve or pipe and opening for floors and exterior walls shall be filled with a non-hardening sealant material and made watertight.

    e) Where fire rated barriers are penetrated, a UL listed fire barrier system shall be installed to retain the fire resistance rating of the barrier.

    f) Escutcheons shall be provided at wall, ceiling, and floor penetrations of piping in occupied areas.

10. The cutting of structural members for the passage of sprinkler piping or for pipe-hanger fastenings is not permitted.

11. Joints

    a) Joints shall be made in accordance with the requirements of NFPA 13.

    b) Joints shall be left exposed until final inspection and testing have been witnessed.

    c) Swing joints are preferred for connecting pendent sprinklers to branch lines.

12. Dielectric unions shall be used to connect dissimilar metals (such as steel to copper) to prevent electrolytic action.

3.2 SPRINKLER SYSTEM ALARM CHECK VALVES

A. Alarm Check Valves (ACV) shall be provided with internally and externally galvanized trim piping and fittings, pressure gages, a retarding chamber, water motor gong, alarm switch, testing bypass, and all necessary pipe, fittings, and accessories.

B. The retarding chamber drain line shall be piped independently of the main drain line.

C. The drain line from the water motor gong shall be piped to discharge through the wall as close to the grade line as possible.

D. Piping between the ACV and a pressure actuated alarm-initiating device shall be galvanized piping not less than 3/8-inch nominal pipe size.

E. Piping supplying the retard chamber, water motor gong, and water motor gong drain shall be galvanized. Galvanized fittings are to be used where galvanized piping is required.

3.3 SPRINKLERS

A. Pendent sprinklers below ceiling shall be aligned, and parallel to ceiling features, walls, etc. In areas without a suspended ceiling, install sprinkler piping as high as possible, using necessary fittings and auxiliary drains to maintain maximum clear headroom.

B. Where two sprinkler systems abut the pendent sprinklers shall be aligned in different directions to distinguish the boundaries of each sprinkler system.

C. Sprinklers under open grating shall be intermediate levels.

D. Sprinklers shall not be installed closer than 6 feet apart.

E. Dry pendant and horizontal dry sidewall sprinklers shall only be installed in screwed tee fittings.

F. Ceiling Areas: Where suspended ceilings are installed, the sprinkler contractor shall install pendent sprinklers as shown on the reflected ceiling plans. Where these plans do not specify the location of the pendent sprinklers, the Contractor shall obtain the reflected ceiling plans and design sprinkler locations at least six inches from ceiling tile edges, 2 feet 6 inches from HVAC supply and return louvers, dimension the locations, follow a repetitive pattern, and locate sprinklers along straight lines to the extent possible. Swing joints shall feed pendant sprinklers from 1-inch outlet tees in branch lines.

G. Stairs: Sprinklers shall be installed throughout stairways, and at every landing.

3.4 ELEVATOR SHAFTS AND MACHINE ROOMS

A. Sprinklers at the tops of all elevator shafts and in the elevator equipment rooms shall be protected from freezing.

B. Provide an OS&Y gate valve to shut off all sprinkler water flow into the elevator shaft and into the elevator machine room. Where possible, piping should be arranged such that a single valve

can shut off water to both locations, and shall be at a readily accessible location, no more than 7’0” above finished floor, inside a clearly marked wall cabinet.

3.5 DRAINS

A. Two-inch drains shall be installed on all main risers and downstream of any interior sectional valves and shall be piped to drain.

B. A pressure gage cock and approved gage shall be installed downstream of interior sectional valves of 4-inch size and larger. 3/4-inch valve auxiliary drains with standard hose threads and caps shall be installed at all low points in the system, where more than five sprinklers are trapped. Where the capacity of trapped piping exceeds 20 gallons, the overflow shall be piped to drain.

C. Inspector's test connections shall be installed on each sprinkler system as near the most hydraulically remote end of the system as possible. The orifice shall be sized to discharge a flow equivalent to the smallest orifice sprinkler in the system. The inspector's test valve shall be located not more than seven feet above the floor in a visible, easily accessible location. For antifreeze systems, the orifice shall be replaced by a plugged outlet.

D. In multi-story buildings where waterflow alarm devices are provided for each floor or where more than one alarm device is provided in a single sprinkler system, a separate inspector's test connection shall be provided for each alarm device. For convenience, in multi-level buildings where more than one inspector's test connection is required, all the valves shall be manifolded together at a single location on the grade floor, with a sight glass and a common drain line discharging outdoors.

E. Drains shall be piped to discharge to drain, and the discharge shall be visible either by open-end or sight drain fitting.

F. Drains and inspector's test connections through outside walls shall be run through the walls as close to the floor or grade line as possible, terminating with a 45-degree galvanized elbow turned down to splash blocks.

G. Concrete splash blocks, 18” x 18” x 4” minimum in size, shall be installed under each drain or test outlet. The top of the block shall be 1 inch above grade, with a slope of 1/2 inch per foot away from the building wall.

3.6 FIRE DEPARTMENT CONNECTIONS

A. The check valve and normally open automatic ball drip (ABD) shall be located at points where they will not be subject to freezing temperatures, and the discharge from the ball drip shall be piped to drain. The ball drip shall close when the flow of water through the valve is in the range of 4 through 10 gpm. All ball drips shall be rated at 175 psi. Use valve- drains in place of automatic ball drip drains when the static head of water above the ABD will exceed 11'6". Check valves shall be UL or FM approved and shall have bodies with the UL or FM stamp.

B. The Fire Department connection shall be installed between 18 inches and 36 inches above grade.

3.7 FIRE HOSE STATIONS

A. Where hose stations are called for on the contract drawings, they shall be 2-1/2-inch hose valves, with 2-1/2” x 1-1/2” National Standard Hose thread adapters, connected to the sprinkler system in accordance with NFPA 13, or as shown on the contract drawings.

B. The centerline of the hose valve shall be installed between 4' and 5' above finished floor.

C. Unless otherwise specified or shown on the drawings, no hose is required.

D. Where hose cabinets are required, they shall be of the horizontal fold, hump type, with full tempered glass doors.

3.8 IDENTIFICATION

A. Control, drain, test, and alarm valves and zone waterflow switches shall be provided with identification signs of the standard design adopted by the automatic-sprinkler industry, or their equivalent.

B. A hydraulic data information nameplate shall be secured to the riser with durable wire, chain, or equivalent, directly above the controlling alarm check valve and shall include the following design data.

1. Building designation

2. Location of remote area

3. Design density

4. Area of application

5. System demand (gpm and psi at base of riser)

6. Data shall be permanently engraved on the nameplate as follows:

a) Material shall be durable plastic or aluminum; Minimum height of lettering is 1/8”.

C. The Contractor shall furnish and place in a plastic envelope attached to each sprinkler alarm check valve riser, one complete set of typed or printed maintenance and operating instructions, a set of prints of the as-built working drawings and hydraulic calculations of the sprinkler system.

D. Contractor shall supply each riser with a cabinet containing maintenance and repair equipment (spare heads, wrench, etc.)

E. Each Contractor shall affix an identification tag on each system riser indicating

Name of the Contractor
Business Address of the Installing Contractor
Phone Number
24-hour emergency contact phone number

3.9 FLUSHING

A. Before connecting sprinkler systems to the main supply, each sprinkler supply line shall be flushed out thoroughly by the Sprinkler Contractor through an unrestricted opening not less than 4 inches in diameter. Minimum flowing quantities are specified in NFPA 13.

B. Failure to comply with this requirement shall necessitate flushing of the entire sprinkler system by the Contractor at no additional cost to the Owner.

C. A 4-inch temporary pipe or two 2-1/2" fire hoses shall be provided by the Contractor to discharge water to a suitable location, as designated by the ARCHITECT/ENGINEER.

3.10 TESTING

A. Aboveground Tests:

1. Prior to acceptance of the installation, the Contractor shall subject the system to the tests required by NFPA 13 for the completion of the Contractor's Material and Test Certificate. In addition, complete operating test of dry pipe, pre-action, deluge, water-spray and foam water systems shall be performed.

2. Hydrostatic testing shall be performed before any ceiling is installed below the sprinkler piping. Each water control valve shall be fully opened and closed under water pressure to ensure proper operation.

3. Where sprinkler locations are roughed-in, using plugged drop nipples projecting below the level of the finished ceiling, the hydrostatic testing shall be performed two times.

   a) First, after the system is completed using the plugged drops, and before the ceiling panels are installed.

   b) Second, after the plugged drop nipples are cut to length for the finished ceiling or replaced with other drop nipples of the correct length, and the sprinklers installed.

4. The addition of sodium silicate (also known as waterglass) and related substances before hydrostatic testing, to stop water leakage, is not permitted.

5. Pipe interiors shall be kept free of debris.

B. Alarm Testing

1. Contractor shall be responsible for testing new alarms and modified alarms installed under this contract. Defective alarms shall be replaced immediately.

3.11 PROTECTION AGAINST FREEZING

A. Sprinkler piping passing through any unheated spaces in, under, or outside buildings exposed to freezing, shall be protected as shown on the plans or in accordance with the methods specified in NFPA 13. Exposed to freezing is defined as any location where the temperature may drop below (40°F) 5°C at any time during the year.

B. Heating shall be provided for sprinkler-protected spaces in lieu of providing anti-freeze systems except where otherwise noted on the drawings or specified herein.

3.12 PROTECTION FOR BACKFLOW PREVENTION

A. A reduced pressure backflow prevention assembly (RPBFP) shall be installed on all new systems and where shown on the drawings for modifications to systems to prevent cross-connection contamination between potable water systems and any fire sprinkler system. Install the RPBFP at the service connection for the fire sprinkler system or as noted on the contract drawings.

B. RPBFP assemblies shall be either FM approved, or UL listed and be approved by the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California (USC-FCCHR) and the International Association of Plumbing and Mechanical Officials (IAPMO).

C. Backflow prevention assemblies used or installed under this contract shall be tested by a "Certified Backflow Control Assembly Tester" who possesses a current (within three (3) years from date of issuance) certificate that confirms successful completion of an approved training course.

D. RDBFP assemblies shall be installed in accordance with AWWA Manual M14 requirements, or as directed by the SDR.

E. If RDBFP devices will be installed outside the building they must be in heated enclosures and with adequate space for inspection, tests, and maintenance.

F. Adequate drainage shall be provided for RDBFP and meet the following:

1. Discharge shall be piped full size (of the relief valve) and extended to a drain.

2. Discharge piping shall be sloped 1/8" per foot and be Schedule 40, galvanized.

3. French Drains are not allowed.

G. The Contractor shall perform an operational test on any new backflow prevention assemblies used or installed under this contract.

3.13 PAINTING AND LABELING

A. Contractor shall paint those portions of fire protection as required by Painting Specification 09900. Labeling shall be as follows:

1. Sprinkler system (e.g., inspectors tests, drain valves) shall be labeled with all information required by NFPA Standard 13.

2. Labeling shall be accomplished with the use of permanently marked weatherproof metal or rigid plastic identification signs. The signs shall be secured with corrosion-resistant wire, chain, or other approved means. These signs shall be provided by the manufacturer, manufacturer's representative, or installer of the sprinkler system.

3. Sprinkler riser shall be labeled with building and sprinkler system riser numbers. Labeling shall be accomplished with the use of "Brady" or approved equal self-sticking labels. The color and size shall contrast the surface that it is applied to.

3.14 DISINFECTION

A. Piping installed under this contract shall be disinfected per AWWA C651 before it is placed in operation, by using one of the following methods.

B. Continuous Feed Method

1. Place calcium hypochlorite in pipe sections when installing pipe or inject liquid chlorine into the system via the injection port. Pipe is filled with water and chlorine concentration shall remain at 10 mg/l for a minimum of 24 hours. During this time, all valves in new section will be cycled open and closed to allow for adequate disinfection. Valves connecting the new or repaired line with mains in active service shall remain closed to prevent chlorine pollution.
2. Samples shall be drawn at 1-, 4-, 8-, 12-, 16-, 20-, and 24-hour marks to determine the chlorine concentration. Acceptable tests are the N-diethyl-p-phenylenediamine (DPD) drop dilution method (AWWA C651, Appendix A) or the High Range Test Kit. The tests shall be done by the Contractor.

C. Slug Method

1. Similar to the continuous feed method. Follow AWWA C651. Chlorine concentration to be 100 mg/l for a minimum of 3 hours. During this time, all valves shall be cycled open and closed to allow for adequate disinfection. Valves connecting new or repaired lines with mains in active service shall remain closed to prevent chlorine pollution.

2. Samples shall be drawn every 15 minutes to determine concentration. Acceptable tests are the DPD drop dilution method or the High Range Test Kit. The tests shall be conducted by the Contractor.

D. Repairing or Cutting into Existing Mains

1. New interior piping surfaces shall be swabbed with a one-percent hypochlorite solution. The section being modified shall be subjected to a high chlorine disinfection process per AWWA C651. The concentration shall be a minimum of 300 mg/l for 15 minutes.

2. Samples shall be drawn before the chlorine is injected and every 5 minutes thereafter. Chlorine concentration shall be tested by the Contractor using the High Range Test Kit.

E. Flushing

1. After the lines have been chlorinated using one of the above methods, it becomes necessary to flush the lines with water until test sample indicates that the water is suitable for drinking. The residual chlorine concentration in the water is to be between 0.2 and 2.0 mg/l, as measured using a Low Range Test Kit.

F. Bacteriological Testing

1. All new and modified water lines require testing for coliform organisms per AWWA C651. The testing shall occur after successful chlorination and flushing of the lines. Samples shall be taken from the new line in sodium thiosulfate treated sterile bottles and analyzed as specified by APHA's Standard Methods for the Examination of Water and Wastewater.

2. Results shall be recorded with the original documentation of results attached. These will be used for auditing purposes.

3. Fire protection lines will not be accepted until a negative bacteriological test is performed. Lines will be chlorinated and flushed repeatedly, until such a negative test is accomplished.

END OF SECTION 21 13 00

SECTION 22 00 00 - PLUMBING INDEX

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Furnish all service tools, equipment, etc., which are required for the complete installation of all Plumbing Work, as indicated on the Drawings, and specified herein. Plumbing work indicated on the Drawings and/or specifications covering other trades shall conform to Division 22 of these Specifications.

B. Work or equipment not indicated or specified, which is necessary for the complete and proper operation of the Plumbing systems shall be accomplished without additional cost to the Owner.

C. Furnish all labor and materials required for plumbing service connections to all the various items of equipment requiring plumbing or piping throughout the project shown on the Contract Drawings (even if not shown on Plumbing Drawings). Coordinate with other trades for the installation of required connections and service.

1.3 PLUMBING DIVISION INDEX

PART 2 – PRODUCTS: Not used.

PART 3 – EXECUTION: Not used.

END OF SECTION 22 00 00

SECTION 22 05 00 - GENERAL PLUMBING REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: General Plumbing Requirements specifically applicable to Division 22 sections in addition to Division 1 - General Requirements.

B. Scope:

1. The work covered by this division consists of performing all operations in connection with the installation of heating, cooling, ventilating, and plumbing including site utility work as indicated under this section. This entire section applies to all mechanical work and all mechanical sections of these specifications. This Contractor shall read and comply with all sections of these specifications including all General and Special Conditions.

1.2 REFERENCES

A. Standard Requirements:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. All work shall be executed in accordance with the local and state codes, ordinances, and regulations governing the particular class of work involved. This Contractor shall be responsible for the final execution of the work under this heading to suit these requirements. In the event of a conflict between the various codes and standards, the more stringent shall govern. Where these specifications and accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect/Engineer. The Architect/Engineer shall prepare any supplementary drawings required, illustrating how the work may be installed so as to comply. On approval of the change by the Architect/Engineer, the Contractor shall install the work in a satisfactory manner without additional cost to the Owner. On completion of the various parts of the work, the installation shall be tested by the constituted authorities and approved, and on completion of the work, this Contractor shall obtain and deliver to the Owner final certificates of acceptance. This Contractor shall furnish copies of each certificate to the Architect/Engineer.

C. The Contractor shall secure all permits and licenses for his work and shall pay all fees in connection with such permits and licenses.

D. The contractor shall hold and save the Owner free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

E. Any and all meter deposits and all utility extension costs shall be paid by the Contractor whose work is done in connection with the service that the meter is connected to.

F. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

1. AGA
   American Gas Association
   1515 Wilson Boulevard
   Arlington, VA 22209

2. ANSI
   American National Standards Institute
   1430 Broadway
   New York, NY 10018

3. ASHRAE
   American Society of Heating Refrigerating and Air Conditioning Engineers
   345 East 47th Street
   New York, NY 10017

4. ASME
   American Society of Mechanical Engineers
   345 East 45th Street
   New York, NY 10017

5. ASPE
   American Society of Plumbing Engineers
   960 Illuminating Building
   Cleveland, OH 44113

6. ASTM
   American Society for Testing and Materials
   1916 Race Street
   Philadelphia, PA 19103

7. AWWA
   American Water Works Association
   6666 West Quincy Avenue
   Denver, CO 80235

8. AWS
   American Welding Society
   2501 NW 7th Street
   Miami, FL 33125

9. CISPI
   Cast Iron Soil Pipe Institute
   1499 Chain Bridge Road
   McLean, VA 22101

10. FM
    Factory Mutual System
    1151 Boston-Providence Turnpike
    Norwood, MA 02062

11. FS
    Federal Specification
    General Services Administration
    Specifications and Consumer Information Distribution Section (WFSIS)
    Washington Navy Yard, Building 197
    Washington, DC 20407

12. NBFU	National Board of Fire Underwriters 5530 Wisconsin Avenue, Suite 750 Chevy Chase, Maryland 20815
13. NEC	National Electric Code (of NFPA)
14. NEMA	National Electrical Manufacturer's Association 2101 L Street, NW Washington, DC 20037
15. NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
16. NSF	National Sanitation Foundation Box 1468 Ann Arbor, MI 48106
17. OSHA	Occupational Safety and Health Administration U.S. Department of Labor
18. PDI	Plumbing and Drainage Institute 5342 Boulevard Place Indianapolis, Indiana 46208
19. TIMA	Thermal Insulation Manufacturers Association Technical Services 1420 King Street Alexandria, VA 22314
20. UL	Underwriters Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

G. Underwriters Laboratories Inc. (UL): All materials, appliances, equipment, devices, or appurtenances shall conform to the applicable standards of Underwriters Laboratories Inc., where such standards have been established.

1.3 DRAWINGS

A. Drawings and specifications shall be considered as cooperative, and work or materials called for by one and not mentioned in the other, or vice versa, shall be done and furnished as though treated by both.

B. In the cases of discrepancies in figures, drawings, or specifications, the Architect/Engineer shall be notified immediately, and his decision shall determine the necessary adjustment. Without such decision, said discrepancies shall not be adjusted by the Contractor save only at his expense, and, in case of any settlement or any complication arising from such adjustment to the Contractor, he shall bear all extra expense involved.

C. Should it appear that the work intended to be done, or any of the matters relative thereto, are not sufficiently detailed or explained on the drawings or specifications, the Contractor shall apply to the Architect/Engineer for such further drawings or explanations as may be necessary, allowing a reasonable time for the Architect/Engineer to supply same, and the Contractor shall conform to same as part of the Contract.

D. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, reference shall be made to the Architect\Engineer whose decision shall be final and conclusive. No alleged oral admission, condonation, or inadvertent neglect on the part of the Architect/Engineer will be accepted as an excuse for inferior work.

E. The mechanical plans do not give exact details as to elevations of ductwork and piping, exact locations, etc., and do not show all offsets, control lines, pilot lines, and other installation details. The Contractor shall carefully lay out his work at the site to conform to the structural conditions, provide proper grading of lines, to avoid all obstructions, to conform to details of installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated, satisfactory operational installation.

F. Should the particular equipment which any Bidder proposes to install, require other space conditions than those indicated on the drawings, the Bidder shall arrange for such space with the Architect/Engineer before submitting his bid. Should changes become necessary on account of failure to comply with these details, the Contractor shall make such necessary changes at his (the Contractor's own expense).

G. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans which shall be checked by the Architect/Engineer and approved before the work is started, Contractor before work proceeds. Interference with structural conditions shall be corrected by the Contractor.

H. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

I. Utilities: The location, size, and pressure of utility lines are shown in accordance with the data given this office by others. As Architect/Engineers, we cannot and do not guarantee the accuracy of this data. Each Bidder shall check and verify this data. The points of connection to utility lines are approximate only and shall be verified by each Bidder prior to submitting his Bid.

J. Site visit: The Contractor shall visit the site prior to bidding and satisfy himself as the conditions under which the mechanical systems are to be installed. No subsequent allowance shall be made in his behalf for failure to make such a visit. Contractor shall examine all work noted under the demolition drawings and all new work and shall satisfy himself as to the extent of work required to be completed.

1.4 SYSTEM DESCRIPTIONS

A. Not Used.

1.5 PRIOR APPROVALS

A. Each equipment item for which the Contractor desires to install equipment other than the specific item identified in the equipment schedule or equivalent equipment by manufacturers specifically named in the schedule, the Contractor shall bear full responsibility to prove to the Engineer that the furnished equipment is equivalent to or better than the specified item. Failure to provide such proof will result in rejection of the shop drawing submittal by the Engineer. Prior written or verbal approval by the Engineer of equipment by other manufacturers will not relieve the Contractor of responsibility to provide equivalence. Prior approval is not required, however, any prior approval given is intended only to provide preliminary agreement that the alternate manufacturer may make equipment that complies with the specification requirements and not that all equipment manufactured by him is acceptable.

1.6 SHOP DRAWINGS

A. Shop drawings or fully descriptive catalog data shall be submitted by the Contractor for all items of material and equipment furnished and installed under this Contract. This shall include piping, ductwork, mechanical equipment, plumbing equipment, control items, etc. The Contractor shall submit to the Architect/Engineer a sufficient number of copies of all such shop drawings or catalog data to provide him with as many review copies as he may need, plus three (3) copies for retention by the Architect/Engineer. No materials or equipment shall be installed until officially approved by the Architect/Engineer.

B. Before submitting Shop Drawings to the Architect/Engineer for review, the Contractor shall examine them and satisfy himself that they are correctly representative of the material or equipment to which they pertain. The Contractor shall so note these Drawings before submitting them. The Contractor's review of Shop Drawings is not intended to take the place in any way of the official review of the Architect/Engineer, and the Shop Drawings which have not been reviewed by the Architect/Engineer shall not be used in fabrication or installing any work.

C. The review of Shop Drawings or catalog data by the Architect/Engineer shall not relieve the Contractor from responsibility for deviations from the plans and Specifications unless he has, in writing, specifically called attention to such deviations as the time of submission and has obtained the permission of the Architect/Engineer thereon, nor shall it relieve him from the responsibility for error of any kind in Shop Drawings. When the Contractor does call such deviations to the attention of the Architect/Engineer, he shall state in his letter whether or not such deviations involve any extra cost. If this is not mentioned, it will be assumed that no extra cost is involved for making the change.

D. After receiving approval on the make and type of materials, the Contractor shall order such materials in sufficient time so that no delay or changes will be caused. This is done to facilitate progress on the job and failure on the part of the Contractor shall render him liable to stand the expense of any and all delays occasioned by failure on this part to provide necessary details. All shop drawings shall be delivered to the Architect/Engineer's office within thirty (30) days from the date of the contract.

E. Shop drawings will be returned unchecked unless the following information is included: reference to all pertinent data in the Specifications or on the drawings, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp. The data

submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings.

1.7 SUBMITTALS

A. Submittal data shall be organized in commercial quality, three ring binders with durable and cleanable covers. Product information for each piece of equipment shall be separated by an indexing leaf with clear tabs. The product name and symbol (i.e. AHU/Air Handling Unit) shall be typed on white paper inserts and placed in appropriate tab. Complete data must be furnished showing performance, quality and dimensions. A signed review by the Architect/Engineer must be obtained before purchasing any equipment.

B. The following items shall be submitted for review by the Architect/Engineer but are not limited to:

1. Pipe Insulation
2. Coils
3. Plumbing Fixtures and Trim
4. Cross Connection Control Devices
5. Pumps
6. Hydronic Air Control Devices
7. Plumbing Equipment
8. Heat Exchangers
9. Flexible Pipe Connections
10. Heating Terminal Equipment
11. Roof Top Equipment
12. Fire Protection Equipment
13. Radiant Heating Equipment
14. Vibration Equipment and Calculations

1.8 QUALITY ASSURANCE

A. General: Comply with Division 1.

B. Welder Qualifications: Welders shall be certified by the American Society of Mechanical Engineers (ASME) National Certified Pipe for the type of work being performed. Current operators' certificates in accordance with ASME standards shall be on file at the site and shall be

available to the Architect/Engineer for examination. Coupons shall be available for review by the Architect and Engineer.

C. Locations of all pipes, ducts, outlets, appliance, etc., as shown on the drawings, are approximate only and are understood to be subject to such revisions as may prove necessary or desirable at the time the work is installed. Each Contractor will be required to install his work with relation to existing building conditions and shall be entirely responsible for the correctness of his work with reference to finished elevations, etc. Piping shown on the drawings is diagrammatic only and their exact locations, depths, and invert elevations shall be as required for proper flow and coordination with other trades.

D. The contract drawing depicts graphically the arrangement of piping and ductwork. Should local conditions necessitate a rearrangement, or if any of the piping or ductwork can be installed to better advantage in a different manner, the Contractor shall, before proceeding with the work, prepare and submit three (3) copies of Drawings of the proposed arrangement for the Architect/Engineer's review.

E. If the Contractor proposes to install equipment, including piping and ductwork, requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the Architect/Engineer review the change before proceeding with the work. The request for such change shall be accompanied by Shop Drawings of the space in question.

F. Each Contractor is responsible for the proper location and size of all slots, holes, or openings in the building structure pertaining to his work, and for the correct location of pipe sleeves.

G. Each Contractor shall coordinate his work with that of all other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipelines which require a stated grade for proper operation. Drainage lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork.

H. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Lubricate all equipment properly in accordance with manufacturer's instructions. Furnish zerk grease fittings on all greaseable bearings.

I. Equipment and Materials: The materials and equipment shall be new and shall be the standard products of the manufacturers regularly engaged in the production of Plumbing, Heating, Cooling, Ventilation, and Fire Protection Equipment, and shall be the manufacturer's latest standard design. Where two or more units of the same class of equipment are required, these units shall be the products of the same manufacturer. However, the component parts of the systems need not be the products of the same manufacturer. Specific equipment specified hereinafter is to be considered a standard of quality and operation. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the drawings. Reference shall be made to the schedules for specific information. The capacities shown are minimum capacities. Variations in the characteristics will be permitted only on written approval of the Architect/Engineer. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible all items of the same type (i.e., pumps, fans, etc.) shall be by the same manufacturer. Where installation instructions are not included in

these specifications or on the plans, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is to be installed.

J. Excavation and Backfilling: This Contractor shall do all necessary excavation and backfill for the installation of the Mechanical systems as may be required. Curb cuts, asphalt, and concrete patching, cutting, and patching existing floor, etc., shall be part of this Contractor's responsibility. No extra payment will be made for rock excavation. Trenches for all underground piping shall be excavated to the required depths. The bottoms of trenches shall be tamped hard and graded to secure maximum fall. Bell holes shall be excavated to assure the pipe resting for its entire length on solid ground. Should rock be encountered, it shall be excavated to a depth of 6 inches below the bottom of the pipe, and before laying the pipe, the space between the bottom of the pipe and the rock surface shall be filled with gravel, thoroughly tamped. Pipe laid in trenches dug in fill shall be supported down in the trenches and shall be filled. No roots, rocks or foreign materials of any description shall be used in backfilling the trenches. The backfill material shall be identical to the surrounding fill material and shall be placed in 6-inch layer, wetted, and compacted to the density of the adjacent soil. See Division 2 for additional information for site utilities. All surplus materials shall be hauled from the project by the Contractor at his expense.

K. Cutting and Repairing:

1. Responsibility of the Contractor whose work is involved. Coordinate with others to prevent unnecessary cutting and repairing.

2. Lay out and locate equipment, openings, and chases. Install sleeves, inserts, and supports. Arrange with those whose work is involved to do cutting and replacing caused by negligence or error with costs reimbursed by the Contractor at fault. Cutting and replacing of existing work shall be the responsibility of the Contractor whose work is being installed.

3. Removal or terminating connections of existing work which is abandoned or replaced shall also be done hereunder to provide correct and finished work.

L. Foundations: All equipment shall be provided with suitable foundations and supports. It shall be the responsibility of the Contractor to provide for the proper locations of these foundations and supports. This applies to all rooftop equipment also.

1. All concrete foundations required by equipment furnished by the Mechanical Contractor shall be constructed by them (except where otherwise noted) the conformity with the recommendations of the manufacturer of the respective equipment, and with the approval of the Architect/Engineer. All corners of the foundations shall be neatly chamfered. Foundation bolts shall be placed in the forms when the concrete is poured. Allow 1 inch below the equipment base for alignment, leveling and grouting with non-shrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary. After removal of the forms, the surface of the foundation shall be rubbed.

2. Unless otherwise noted, foundations shall be a minimum of 6-inch high. All concrete work performed by these Contractors shall conform entirely to the requirements of the Concrete Specifications which describe this class of work.

M. Code Requirements: Comply with state and local code requirements and ordinances. Call for inspections required by responsible building inspection authority.

N. Applicable Building Codes and Ordinances: Including the latest edition of each code, but not limited to the following:

1. International Building Code.

2. Uniform Mechanical Code.

3. Uniform Plumbing Code.

4. Governing Fire Department Requirements

5. Utility Company Requirements

6. National Fire Protection Association Standards

7. NFPA 70 - National Electrical Code

8. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

9. NEPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

10. NFPA 13 - Sprinkler Systems

11. NFPA 101 - Life Safety

12. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Laden Vapors from Commercial Cooking Equipment

13. International Energy Conservation Code 2018

O. Access Panels

1. Similar to Milcor, or as noted on the drawings, size as required for concealed expansion joints, valving, gauges, balancing dampers, valves, traps, pitot stations, equipment and similar items requiring accessibility. Notify the General Contractor of each access panel location and the required size. Panels shall be proper type for ceiling or wall in which they are installed. The panels shall be furnished under this section of the Specifications, unless otherwise directed, but shall be coordinated to be compatible with walls and ceilings furnished under other sections.

1.9 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1.

B. Large Items: Make arrangements with other trades on the job for introduction into the building of equipment too large to pass through finished openings.

C. Acceptance: Check and sign for materials to be furnished by others for installation under Division 22 upon delivery. Contractor shall be responsible for the storage and safekeeping of such materials from time of delivery until final acceptance.

D. Protection: Close ends of pipe at the close of each working day during construction to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Protect fixtures and equipment against damage during mechanical work with heavy paper or plastic until final clean-up.

E. Storage: Store equipment in covered enclosure or wrap with weather tight 6 mil Visqeen.

F. Shipping Protection: Protective casings, crating, and coverings to remain in place until start-up of equipment.

1.10 PROJECT CONDITIONS

A. Performance: All systems are to be rated at 3,575 ft.] elevation.

1.11 SEQUENCING AND SCHEDULING

A. General: Comply with Division 1.

B. Schedule: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

C. Utility Interruptions: Schedule mechanical utility interruptions with the Architect/Engineer/Owner minimum of seven (7) days prior to the requested outage. Plan work so that duration of the interruptions a maximum of one day.

1.12 CONTROLS WIRING AND ELECTRICAL EQUIPMENT

A. All mechanical equipment controls wiring, conduit, relays, interlocks, and all accessories required for a completely operational controls system shall be the complete responsibility of the mechanical contractor. The mechanical contractor has the option to hire the project electrical contractor or any qualified controls contractor to install mechanical controls wiring and conduit. Refer to specification 251000 for installation requirements. Refer to Specification Section 253000 for coordination requirements between mechanical, electrical, and controls subcontractors.

B. Electrical items such as disconnect switches and motor starters associated with equipment provided by Division 22, when specifically mentioned to be furnished by the Mechanical Contractor, whether in these specifications or on the Electrical or Mechanical Drawings, shall be furnished by the Contractor. These items shall be mounted and connected as required for a completely operational system. See Control Systems Specification for further information.

C. All electrical equipment characteristics (voltage, etc.) must be verified by the Contractor prior to ordering. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Architect/Engineer of the change and shall then coordinate the change with the Electrical Contractor and shall pay all additional charges in connection with the change.

D. All motors shall meet all the requirements of all Electrical Divisions.

1. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general-purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. All motors shall have copper windings. All motors to have minimum power factor of 85% or have switched correction to 90%. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40°C rise and total temperature rise of 65°C ambient and when powered from the system voltage feeding the motor. TEFC motors shall a service factor of 1.00 with total temperature is of 65°C in the above conditions. Motors located in areas exceeding 40°C ambient shall be factory-rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors. Single phase motors of 1/10 HP or less may be shaded pole induction motors.

1.13 PROTECTION AGAINST HAZARDOUS CONDITIONS

A. The Contractor shall take precautions against hazardous construction conditions at all times during construction. The final condition of the facilities shall be safe, and where safety to operating personnel is jeopardized, suitable signage shall be posted.

B. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operating personnel, shall be cut back and/or protected to reduce the risk of injury. All openings between floors shall be protected with barriers around the openings, gratings across the openings, or steel bars through the openings to avoid and protect against injury.

1.14 HAZARDOUS SIGNS

A. Equipment room contains moving or rotating parts, floor openings, or other potentially hazardous environments and shall include a sign on the door entering it that shall read similar to the following: **Hazardous Area - Authorized Personnel Only.**

1.15 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Mechanical Contractor shall furnish to the Owner a bound (three (3) ring binder) manual in triplicate, containing complete repair parts lists, and operating, service, and maintenance instructions on all mechanical equipment, fixtures, and systems, as noted below:

1. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect/Engineer, Sub-consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

2. For Each Product System: List names, addresses and telephone numbers of Sub-contractors and suppliers, including local source of supplies and replacement parts.

3. Product Data: Mark each sheet to clearly identify specific product and component parts, and data applicable to installation. Delete inapplicable information.

4. Warranties and Bonds: Bind in copy of each.

5. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

6. Include color-coded wiring diagrams as installed for control system.

7. Operating Procedures: Include start-up, break-in and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.

8. Maintenance Requirements: Include routine procedures and guide for troubleshooting, disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

9. Provide servicing and lubrication schedule and list of lubricants required.

10. Include manufacturer's printed operation and maintenance instructions.

11. Include sequence of operation by controls manufacturer.

12. Provide original manufacturer's part list, illustrations, assembly drawings and diagrams required for maintenance.

13. Provide control diagrams by controls manufacturer as installed.

14. Provide charts of valve tag numbers, with locations and functions of each valve, keyed to flow and control diagrams.

15. Provide list of original manufacturer's spare parts and recommended quantities and to be maintained in storage.

16. Include Test and Balance (T&B) Reports as specified in Section 230593.

B. The Mechanical Contractor shall also provide training as required by Section 230100 to the Owner's operation and maintenance personnel.

1.16 OPERATION PRIOR TO ACCEPTANCE

A. The Owner shall have the right to operate any and all apparatus as soon as and as long as it is in operating condition, after Owner personnel have received operational training, whether or not such apparatus has been accepted as complete and satisfactory, except that this shall not be construed to mean operations before any required alterations or repairs have been made. This operation does not indicate acceptance of the equipment by the Owner. When the Contractor enters into a contract with the Owner, he agrees to the above.

1.17 WARRANTY AND SERVICE PROGRAM

A. Due to the critical performance requirements and to clearly establish warranty responsibility for this project, the Contractor shall provide a full-service maintenance and warranty program to the Owner for one full year after beneficial occupancy (substantial completion).

B. This service program shall be included as part of the base bid and shall include service, maintenance, repair, replacement, lubrication, temperature control calibration and repairs, and documenting proof for all service and maintenance work on all equipment and system furnished by the Contractor.

C. A single representative in the employment of the Contractor shall be responsible for coordination and follow through of this program. This representative's name and phone number shall be submitted to the Owner as part of the maintenance manuals and supportive data. The Contractor shall respond to a request for service with 24 hours if so requested.

D. During this first year of operation, the following sequence of maintenance service shall be performed as a minimum.

1. Clean strainers in piping.

2. Fans and/or pumps be lubricated and oiled once every four (4) months.

3. Controls shall be calibrated throughout the facility at the end of six (6) months (following substantial completion). Any leaks in the piping systems shall be repaired.

4. All equipment manufacturer's service recommendations shall be followed during this period.

1.18 FLUSHING AND DRAINING

A. It shall be the responsibility of this Contractor to properly drain and flush all ducts and pipes before use or acceptance to ensure that all debris is completely removed. Damage caused by such debris remaining in the ducts or pipes shall be repaired by this Contractor at his expense. This Contractor shall demonstrate to the Architect/Engineer's representative that all piping is clean.

1.19 CLEANING

A. This Contractor shall remove from the building construction site all rubbish and dirt as it accumulates under the contract. At completion, all areas shall be broom cleaned and all obstructions, surplus materials, etc., removed.

1.20 GUARANTEE

A. The Contractor shall guarantee all materials, equipment, and workmanship furnished and installed by him under this Contract, to be free from all defects of workmanship and materials, and shall agree to replace at his expense, without expense to the Owner, at any time within one year after installation is accepted by the Architect/Engineer, any and all defective equipment, parts, etc., that may be found. (This excludes normal maintenance and daily servicing of equipment which is the Owner's responsibility.)

1.21 FLOOR, WALL, AND CEILING PLATES

A. Where exposed pipes pass through floors, finished walls, or finished ceiling, they shall be fitted with chromium-plated escutcheons of an approved pattern. Escutcheons and plates in Mechanical Rooms do not require chrome finish.

B. This Contractor shall be responsible for providing and installing all counter flashing. All openings in the roof shall be flashed and counterflashed. Use four-pound lead flashing materials for all vent lines and welded flashing in steel lines passing through roof. The Mechanical Contractor shall notify the General Contractor where each roof penetrations is and the size of the opening.

1.22 PIPE SLEEVES

A. Schedule 40 steel pipe sleeves or pipe sleeves made of No. 20 gauge galvanized steel, properly secured in place with approximately 1/4" space between each sleeve and the surface of the pipe and/or insulation passing through it, shall be provided for all pipes passing through concrete floors, roofs, and masonry walls. All pipe sleeves shall be fixed in place as the walls and floors are built up. The Contractor shall furnish and locate all sleeves and pipes passing through concrete floors, exterior masonry walls, and roofs shall be made watertight with approved non-hardening plastic material. Sleeves through pipe chase or equipment room floors shall project a minimum of 2-inch above the floor and shall be of black steel pipe with waterproof flange at center of floor thickness. Each sleeve through a fireproof wall shall be packed with approved fireproof rope in the annular space.

1.23 PIPE HANGERS

A. Pipe hangers shall be Fee and Mason of a type suitable for each use. Perforated straps shall not be used in any work. For ferrous pipes up to and including 4 inch in size, use Fee and Mason Fig. 199 malleable iron, adjustable, split ring, swivel hanger. For plumbing piping larger than 4 inches, use Fee and Mason Fig 239 steel clevis hanger. Where several pipes are parallel at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on rollers where indicated on the Drawings. For copper pipes up to and including 3 inch in size, use Fee and Mason Fig. 360 malleable iron, copper plated hangers. For copper pipes larger than 3 inches, use Fee and Mason Fig. 364 copper plated clevis hanger.

B. Hanger rod sizes shall conform to the following schedule:

1. Pipe up to and including 2"	3/8" rods
2. Pipe 2-1/2", 3" and 3-1/2"	1/2" rods
3. Pipe 4" and 5"	5/8" rods
4. Pipe 6"	3/4" rods
5. Pipe 8”, 10”, and 12”	7/8” rods

C. Unless shown otherwise on the Plans, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following spacing:

1. Pipe up to and including 1-1/4"	8'
2. Pipe 1-1/2" and 2"	10'
3. Pipe 2-1/2" and 3"	12'
4. Pipe 3 1/2” and 4”	14’
5. Pipe 5” and 6”	16’
6. Pipe 8” and 10”	20’

D. Unless shown otherwise on the Plans, all horizontal runs of copper piping shall be suspended from the floor or roof construction as the case may be, by means of hangers with the following maximum spacing:

1. Pipe up to 3/4" in size	5'
2. Pipe 1" and 1-1/4"	6'
3. Pipe 1-1/2" and larger	10'

E. There shall be a hanger within 2 inches of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps at each floor. Vertical pipes within a space shall have not less than two supports.

F. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting, nor shall it be supported from equipment connection.

G. Expansion bolts shall be Ackerman-Johnson or Hilti.

H. Beam clamps suitable for use with this type of steel construction involved shall be Grinnell.

1.24 PRESSURE VESSEL CERTIFICATION

A. Not used.

1.25 ISOLATION

A. Excessive vibration or objectionable noise created in any part of the building by the operation of any equipment furnished and/or installed under the Mechanical Contract will be extremely objectionable and the Contractor shall take all precautions against the same by isolating the various items of equipment from the building structure and by such other means as may be

necessary to eliminate all excessive vibration and objectionable noise produced by any equipment installed by them, and consequently, they shall design all foundations, supports, etc., for their equipment, and all piping with this end in view. In addition, these Contractors shall supervise the construction of all foundations and supports, whether they build them or not, in order that they may be constructed in such a manner as to prevent the transmission of objectionable noise and/or excessive vibration. Submit calculations on all vibration isolation equipment.

B. All equipment having moving parts shall be isolated from the building structure by means of Korfund isolation materials, unless specifically noted otherwise. All isolators shall be the same brand and shall be supplied from the same source. Equipment manufacturer's recommendations shall be followed in the isolation of equipment.

C. Vibration isolators shall have sufficient resilience to meet the following minimum efficiencies:

Motor HP	Equipment Room
Up to 5	90%
7-1/2 to 15	93%
20 to 40	95%
50 to 100	97.5%

D. Spring isolators shall be of the housed type with ribbed pads bonded to the underside of the baseplate or may be unhoused stable springs. Isolators shall be furnished with snubbers and limit stops where so recommended by the equipment manufacturer.

E. The Supplier of the isolating equipment shall, upon completion of the job, check all isolating materials and verify that they are installed properly, and submit a report in writing to the Architect/Engineer.

1.26 TESTING

A. Before completion of this project, the Mechanical Contractor shall test all materials and equipment which normally require testing. All piping, etc., shall be tested to meet code requirements or the Specification requirements, whichever is more stringent.

B. All equipment shall be operated sufficiently long enough to prove to the Architect/Engineer that the equipment performs satisfactorily and meets the requirements set forth on the Plans or in these Specifications.

1.27 CERTIFICATIONS

A. Before receiving final payment, the contractor shall verify that all equipment furnished, and all work done is in compliance with all applicable codes mentioned in these Specifications. Submit certifications and acceptable certificates to the Architect/Engineer.

1.28 GENERAL PIPING INSTALLATION REQUIREMENTS

A. Provisions for Drainage: All piping systems shall be installed so that they may be easily drained. Drain caps, plugs, or hose bibbs shall be installed at low points. Grade piping toward drain locations.

B. Alignment: All installed pipelines shall be straight and shall remain straight against strains. Proper allowance shall be made for expansion and contraction.

C. Clean as Installed: All piping shall be kept free from scale or loose dirt when installed and must be kept clean during the completion of the installation. All openings in the piping system shall be capped or plugged while awaiting further connections. All detergents, solvents and other cleaning agents shall be compatible with the materials of fabrication of the system in which they are used. They shall not adversely affect the materials of mechanisms in the systems and they shall be acceptable to equipment manufacturers. All detergents, solvents, and other cleaning agents shall also be compatible with the process streams to be handled by the systems in which they are used.

D. Insulated Fittings: Install between any dissimilar metals such as steel and copper.

E. Expansion and Contraction: The Contractor shall make all necessary provisions for expansion and contraction with proper fittings, anchors, dresser couplings, loops, etc. Install flexible connectors on each pipe at each building expansion joint.

F. Welding: Refer to Paragraph 1.29 of this section of these specifications.

G. Bending: No bending of pipe will be permitted.

H. General: The installation shall be coordinated with respect to space available with heating, cooling, ventilating, and electrical installation. In every instance where there is a conflict in the routing of the piping and the ducting, the routing of the ducting shall govern. Installed piping shall not interfere with the operation or accessibility of doors or windows, shall not encroach on aisles, passageways, and equipment, and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping, installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping above ground shall be run parallel with the lines of the building unless otherwise noted on the drawings. Unless otherwise shown on the drawings, horizontal piping shall pitch down in the direction of flow with grade of not less than 1 inch in 40 feet. Piping connections to equipment shall be in accordance with details shown on the drawings or as recommended by the equipment manufacturer. Service pipe valves and fittings shall be kept a sufficient distance from other work to permit finished covering not less than 1/2 inch from such other work, and not less than 1/2 inch between finished covering on the different services.

I. Installation of Valves: Valves shall be installed at the locations shown on the drawings and where specified and where directed at site. Gate valves shall be used unless otherwise shown, specified, or directed. All valves shall be installed with their stems horizontal or above. Where tight shutoff is required, a composition seat globe valve or resilient seat ball valve shall be used.

J. All valves which must be used during operation, all control valve assemblies, instrument control cases, liquid level controls, gage glasses, orifices, relief valves, and other equipment which must be observed, adjusted, or serviced during operation shall be located conveniently accessible from an operating platform or grade.

K. In general, relief valves within processing unit limits shall be located conveniently accessible from an operating platform or grade.

1. Those in non-hazardous service, such as water, shall discharge directly to outside.

2. Relief valves should have no piping between the vessel or line and the valve inlet, except as shown on the drawings.

3. Relief valves shall be installed in a vertical position. Vent piping shall be braced and supported in a manner that will not produce excessive stresses in the relief valve and will permit removal of the relief valve without necessary temporary supports for the vent lines.

L. Equipment Connections: All piping connections to pumps and other equipment shall be installed without strain at the pipe connection of the equipment. The contractor shall be required as directed to remove the bolts in flanged connections or disconnect piping to demonstrate that the piping has been so connected. Pipe connections to equipment shall be made with unions or flanged fittings. Provide removable headers for large equipment for service access.

M. Joints

1. Flanged Joints: All flanged joints shall be face matched. Raised face flanges shall not be mated to flat-faced cast-iron flanges on valves or equipment. The raised face must be turned off. All flanged bolt holes shall straddle the horizontal and vertical center line unless otherwise noted.

2. Screwed Joints: Screwed pipe joints shall have American Standard Taper Pipe Threads ANSI-B2.1 Latest Edition. Burrs formed when cutting pipe shall be removed by reaming. Care shall be taken that the inside of pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Joints shall be made perfectly tight by the use of Teflon tape or approved Teflon thread sealing and lubricating compound.

3. Solder-Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool or wire brush before seating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for serrated fittings on water, compressed air below 60 psig, and vacuum lines shall be made with a 95 percent tin and 5 percent antimony. Cored solder or solder containing lead will not be permitted.

N. Reducers: Reduction in pipe size shall be made with one piece reducing fittings. Bushings reducing at least two pipe sizes will be acceptable only when there is no room for reducing couplings or swaged nipples.

O. Unions: All piping unions shall be of the ground joint type constructed from materials equivalent in alloy composition and strength to other fittings specified with which they are used. Union

Pressure classes and end connections shall be the same as the fittings used in the lines with the unions. Steel unions shall have hardened stainless steel seating surfaces on both faces.

P. Hanger Supports:

1. All hanger rods used to support piping, conduit, mechanical units, equipment, trapezes, and other items shall be straight and installed plumb, regardless of length. Do not bend rods to adapt to sloped or rotated structural members, secondary support members or to sloped mounting holes on supported equipment. Contractor shall utilize available swivel, hinged, or rigid mounting techniques designed to accommodate a slope or rotation, or shall design a custom solution. Selected techniques for each application shall be submitted for approval prior to use.

2. Do not bend rods to circumvent an obstruction.

3. Loads on hanger rods shall be applied in direct tension. Do not apply compression, lateral or moment loads to hanger rods. Install bracing or additional supports to prevent hanger rod from incurring non-tension loading.

4. Do not create offsets in rods; use only in-line couplers, and only when length of coupled rod exceeds standard available length (typically 12 feet), or when full lengths cannot be placed in position. Provide additional horizontal bracing to prevent swaying of supported piping or equipment.

5. Do not straighten bent rods for subsequent use. If a rod becomes bent, cut off and discard the bent portion. Remaining straight portion of rod may be used.

1.29 WELDING

A. All welding of piping covered by this specification, regardless of condition of service shall be accompanied as follows:

1. The welding shall be in accordance with the recommendations of the American Welding Society. Mitering of pipe to form elbows, notching to form these, or any similar construction will not be permitted. Welding fittings shall be installed on all welded lines. Joints to be welded shall be properly aligned and spaced, using special welding clamps where necessary. All welders to be employed shall have passed qualification tests prescribed by the National Certified Pipe Welding bureau (or by another reputable testing laboratory or agency) using procedures approved by the American Society of Mechanical Engineers or the American Welding Society. The welders will be required to pass qualification tests when the work of the welder creates a reasonable doubt as to his proficiency. Tests shall be conducted at no additional expense to the Owner.

2. Each welder shall, in addition to having passed the prescribed qualification tests (as noted in Paragraph 1.30.A.1), prepare sample coupons at the job site on a portion of pipe that is cut such that the cross section of the weld is open to view. The sample weld should be prepared using a 6-inch diameter pipe. The sample shall reflect a continuous weld with perpendicular cut out to show the weld in cross sectional view. This sample, when accepted and approved by a certified welding inspector, shall be used as a standard of quality to compare to other welds that this welder will be performing on the job. This same sample weld will also be a

basis for accepting or rejecting the welder for working on this project. The sample weld shall be identified with a date and the welder's name and shall be kept at the site throughout the project.

3. All welding on pressure piping shall conform to all of the requirements of the American Society of Mechanical Engineers Code for Pressure Piping - B31.1 (An American National Standards Institute publication), as defined in the latest edition of the ANSI Power Piping B31.1 Manual. All welding shall also conform to all of the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. All chapters, current addenda and supplements of these manuals shall apply. This code shall be used to establish standards of performance and quality of welds. However, the Owner reserves the right to perform radiographic testing of all welds, to compare any of the welds to the approved "standard" sample welds of each welder, and to compare the welds to the welding diagrams and sketches of those recommended in the ANSI B31.1 Power Piping Manual. The intent is to obtain the highest quality welding job possible. The cost of any initial radiographic testing, for random inspection, shall be paid for by the Owner. If radiographic random testing reveals that a weld is defective, the Contractor shall bear the cost of all repairs and re-testing necessary to be made to subject weld until conformance with radiographic tests is reached. The potential for random radiographic testing and welding quality control applies to all pressure piping systems in this project, including systems below 100 psig. If a question should arise regarding the possibility of faulty welding or if there are obvious visual defects in the welding, the Contractor shall be required to correct such deficiencies to a quality level consistent with the recommendations, welding diagrams and sketches in the ANSI B31.1 Manual. The quality level shall also reflect that of the approved sample welds accomplished by each welder for this particular project.

1.30 TESTING FOR PIPING SYSTEMS

A. General: Before insulation is applied, all piping, equipment, and accessories installed under this contract shall be inspected and tested by the Contractor. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying tests. Prior to performing tests, all lines shall be "blown" free of all loose dirt and foreign particles. The lines shall then be thoroughly flushed with water (liquid lines only) at a sufficient flow rate and period of time, to ensure complete cleaning of the lines of all dirt, scale, and foreign matter. Satisfactory flushing of the lines shall be subject to approval. After testing and flushing lines, all filters and strainers shall be cleaned.

B. Safety: Since the Risk of failure, with the attendant possibility of injury, is appreciable greater with further testing, all safety measures required by codes or ordinance or reasonable applicable to the situation shall be taken.

C. Concealment: Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Compression joint underground piping may be backfilled prior to pressure test except that joints shall remain exposed until after the test, but tie rods, clamps, etc., shall be in place and fastened.

D. Pressure Ratings: These tests shall not be used to establish pressure ratings.

E. System Protection: Protect all piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during the filling, testing, and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating. Note that where significant differences in elevation exists, there is a risk of overpressure in the lower portions of the system in order to attain test pressure in the upper portion of the system

F. Test Temperature: Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes require testing above a specified minimum temperature.

G. Sectionalizing: Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

H. Temporary Supports: During hydrostatic testing of lines provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

I. Testing: Domestic hot and cold water piping and heating water piping shall be tested hydrostatically at the test pressures specified and shall show no drop in pressure in a 2 hour period. Leaks shall be located by soap testing.

1. Test Pressures:

a) Natural gas piping: as required by governing code

b) Domestic Hot and Cold Water: 100 psig or 50% more than operating pressure, whichever is greater.

J. Sanitary Waste and Soil System:

1. After all soil and waste pipes and vent stacks have been installed, the outlets shall be plugged, and the piping system filled with water in vertical sections to the highest point of the system and allowed to remain filled for twenty-four (24) hours and shall prove to be leaktight under such conditions. A one-inch drop will be allowed in water level in standpipe. This test may be conducted in segments as required by the sequence of construction. Contractor shall certify in writing that all tests were satisfactorily completed before piping was concealed and shall submit the certification to the Architect/Engineer for his records and for transmittal to the owner.

K. Test Report

1. A detailed report of pressure tests on piping and equipment shall be forwarded in duplicate to the Architect/Engineer. This report shall show date of test, lines tested, test medium, length of time test pressure was held, pressure drop or rise, and extent of venting or repressurizing.

1.31 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other sections of these specifications covering the work of other trades which must be carried out in conjunction with the mechanical work so that the construction

operations can proceed without harm to the Owner from interference, delay, or absence of coordination.

1.32 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions covering the mechanical work at the building. No extra compensation shall be claimed or allowed on account of difference between actual dimensions and those indicated on the drawings. He shall examine the adjoining work on which Mechanical work is dependent for maximum efficiency and shall report any work which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable work conditions affecting Mechanical work.

1.33 SAFETY GUARDS

A. The Mechanical Contractor shall furnish and install safety guards required in order to obtain certificates of inspection from all authorities having jurisdiction. All belt driven equipment, projecting shafts, and other rotating parts shall be enclosed or adequately guarded. Provide coupling guards on all rotating shafts.

1.34 PROTECTION

A. All work, equipment, and materials shall be protected at all times to prevent obstruction, damage, or breakage. All pipe openings shall be closed with caps or plugs during installation. All equipment shall be covered and protected against dirt, water, chemical, or mechanical injury. At the completion of the work, all equipment shall be thoroughly cleaned, and the entire system shall be delivered in a perfect, unblemished condition.

1.35 PAINTING AND IDENTIFICATION

A. All equipment shall be delivered to the job with suitable factory finish. Should the finish be marred in transit or during installation, it shall be finished to present a neat, workmanlike appearance.

B. Except as elsewhere hereinafter specifically required, any painting of equipment, piping, ductwork, grilles, insulation, etc., furnished and installed under this Section of the Specifications will be done by the Painting Contractor. However, the Mechanical Contractor shall leave his equipment clean and free from any grease, dirt, rust, etc., and in suitable condition for painting.

C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.

D. The piping shall be painted the basic color as indicated in other sections of these specifications and shall be marked every 10 feet on centers with Brady pipe markers. Arrows, approximately 6 inch in length and spaced about 10 feet on centers shall indicate the direction of the flow pipe. Locate additional labels as required in Mechanical Rooms. Staple in place, brush with clear lacquer. Markers shall state pipe size, flow direction, and pipe usage (such as "cold water," etc.).

1.36 RECORD DRAWINGS

A. The Contractor shall, during the execution of the work, maintain a complete set of drawings upon which all dimensional locations of equipment piping and all deviations and/or changes in the work shall be recorded. Water, storm, and drainage mains shall be delivered to the Architect/Engineer in good condition upon the completion and acceptance of the work and before final payment is made.

1.37 SUPPLIER RESPONSIBILITY

A. Each supplier, whether furnishing equipment as specified or as a substitution shall be responsible for certifying that the equipment is properly installed and that the warranty is valid. Submit written reports on the installation and the equipment performance when requested to do so by the Architect/Engineer (or his representative). Each supplier shall be responsible for furnishing qualified personnel at the job site at anytime requested by the Architect/Engineer (or his representative) during the construction or warranty periods.

END OF SECTION 22 05 00

SECTION 22 05 23 - VALVES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. All valves except lubricated plug valves and butterfly valves shall be manufactured by Nibco, Hammond, Lunkenheimer, Kennedy, Stockham, Walworth, Powell, or Milwaukee.

B. Lubricated plug valves shall be as manufactured by Rockwell, Milwaukee, or Walworth.

C. Butterfly valves shall be as manufactured by W.C. Norris, Centerline, Nibco, Demco, Grinell, Milwaukee, or Keystone.

1.3 RELATED WORK IN OTHER SECTIONS

220000	PLUMBING INDEX
220500	GENERAL PLUMBING REQUIREMENTS
220700	PIPING INSULATION
221113	DOMESTIC WATER SYSTEMS
221123	NATURAL GAS PIPING SYSTEMS
221313	SOIL AND WASTE PIPING SYSTEMS
230548	VIBRATION ISOLATION AND EXPANSION COMPENSATION

1.4 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve with metal chain. Tag shall indicate both the service and function of each valve. The Contractor shall furnish two prints of drawings showing floor plan for each floor with all valves accurately located and labeled. These drawings shall be neat and easily read.

PART 2 – PRODUCTS

2.1 VALVES

A. Domestic water:

1. Gate Valves 2" and Under: Nibco No. T134, rising stem, ductile iron hand wheel, union bonnet, solid wedge disc, bronze body, Class 150 psi working pressure.

2. Gate Valves 2-1/2" and Larger: Nibco No. F617-0, bronze trimmed, solid wedge disc, iron body, O.S. & Y., 125 psi working pressure.

3. Swing Check 2" and Under: Nibco No. T433, swing type, Y-pattern, all bronze, renewable seat & disc, regrinding, 200 psi working pressure.

4. Swing Check, 2-1/2" and Larger: Nibco No. F938-31, iron body, bolted bonnet, Class 150, bronze trimmed, check valves installed at discharge of pumps shall be non-slam type.

5. Globe Valves 2" and under: Nibco No. T235, union bonnet, integral seat, Class 150 bronze body with renewable disc.

6. Globe Valves, 2-1/2" and Larger: Nibco No. 718-B, bolted bonnet, cast iron body, 125 psi working pressure 0.S. & Y., pattern bronze trimmed.

7. Gate Valves 3" and Under for Copper Pipe: Nibco No. S134, union bonnet, Class 150 bronze rising stem wedge disc.

8. Globe Valves 2" Under for Copper Pipe: Nibco S-235, Class 150, bronze union bonnet, integral seat, renewable seat and disc.

9. Angle Valves 2" and Under Copper Pipe: Nibco T335, Class 150, Union Bonnet, integral seat, renewable seat & disc.

10. Angle Valves 2 1/2" and Larger: Nibco F8180-B, Class 125, bolted bonnet cast iron, renewable seat & disc., bronze trim.

11. Check Valve for 3" and under for Copper Pipe: Nibco S-433, Y-pattern, swing type, all bronze, renewable seat & disc.

12. Manual Balancing Valves:

    a) 2" and Under: Nibco T-585-70 ball valve or Milwaukee Butterball butterfly valve with calibrated flow set handle.

    b) 2-1/2" and Larger: W.C. Norris butterfly valves with lever with infinite throttling position as specified below.

13. Circuit Balancing Valves: Balance Valves shall be "Circuit Setter" balance valves as manufactured by Bell & Gossett.

14. Automatic Balancing Valves: Shall be spring loaded, variable orifice type capable of maintaining present flow within 5% over an operating pressure differential of at least 14 times the minimum valve pressure requirement. Maximum controlled pressure differential shall be at least 75% of the system pump head. Valve shall be Griswold Automatic Flow Control Valve or approved equal. At Contractor's option, automatic flow control valves may be used in 2" size and above in lieu of manual balancing valves.

15. Butterfly Valves: Lug type butterfly valves, ductile iron or cast-iron body, bronze blade, stainless steel shaft and with EPT liner for tight shutoff up to 150 psi, bonded seat. Valves to

be suitable for mounting between flanges, with lugs drilled and tapped so that pipeline can be disconnected with the valve still holding pressure. Valves 3" and smaller to have lever operators with infinite throttling positions. Valves 4" and larger to have worm gear and hand wheel manual operators. Butterfly valves may be used in lieu of gate valves for water service 2" and larger. Liner shall be suitable for -30 F to + 275 F.

16. Ball Valves:

    a) 1/2" to 2": Nibco No. T-585-70, two-piece body, bronze, screwed ends, Teflon seats, straight through flow design.

17. Lubricated Plug Valves: Rockwell Mfg. Co. "Permaturn" lubricated plug valves Fig. No. 143. Provide valve handle for each valve. Valves shall have tapered plugs with thermally bonded lubricated film.

18. Water Pressure Relief Valves for makeup to heating and cooling systems, and relief for heating and cooling system, Bell & Gossett No. 1170 unless otherwise noted.

19. Relief Valves for hot water generators and heating converters. ASME labeled temperature and pressure relief valves shall be installed on the hot water generator. Pressure relief valve shall be installed on the converter set for 30 psi. Valves shall be sized for the full heating capacity. Discharge from valves shall be piped to the nearest floor drain.

20. Drain Valves: Nibco No. T134, 3" and smaller.

PART 3 – EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

B. Gate and globe valves shall be installed with stems up.

C. System balancing valves shall be installed where shown or required to balance waterflows to all system components. In general balancing valves shall be provided at the following locations:

1. Each pump discharge, lubricated plug valve.

2. Each main branch circuit, circuit balancing valve.

3. At each water coil, circuit balance valve.

END OF SECTION 22 05 23

SECTION 22 07 00 - PIPING INSULATION

PART 1 – GENERAL

1.1 SUMMARY

A. Furnish and Install:

1. Piping insulation

2. Jackets and accessories

1.2 RELATED DOCUMENTS:

A. The General Provisions of the Contract, including General and Special Conditions and the General Requirements apply to the work specified in this section.

B. Insulation furnished under this specification shall comply with all requirements of the State Energy Code and the recommendations of the latest edition of ASHRAE 90.1 and these specifications. The more stringent of these shall be the standard for the work provided under these specifications.

C. The work included under this specification consists of furnishing all labor, accessories, equipment, and materials necessary for installation of all piping, and mechanical equipment insulation systems. This includes but is not limited to:

1. Thermal Insulation

a) Domestic hot water piping

b) Refrigerant piping

c) Heat exchangers

2. Condensation Prevention Insulation

a) Domestic cold-water piping

b) Roof drain and overflow piping and roof drains

c) Cooling coil condensate piping

1.3 RELATED WORK IN OTHER SECTIONS

220000 PLUMBING INDEX
220500 GENERAL PLUMBING REQUIREMENTS
230500 GENERAL HEATING, VENTILATING AND AIR CONDITIONING REQUIREMENTS

1.4 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded Hot Plate Apparatus.

C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

D. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

E. ASTM C518 - Test Methods for Steady-State Heat Flux, Heat Flow Meter Apparatus.

F. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

G. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

H. All preformed Fiberglass pipe insulation with factory applied jackets shall meet the following standards:

ASTM E84 - Surface Burning Characteristics of Building Materials

ASTM E96 – Jacket Permeance

ASTM C335-Steady-State Heat Transfer Properties of Horizontal Pipe Insulation

ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

ASTM C547 - Mineral Fiber Preformed Pipe Insulation

ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

ASTM C795 – Thermal Insulation for use in Contact with Austenitic Stainless Steel

ASTM C1136 – Flexible Low Permeance Vapor Retarders for Thermal Insulation: Types I-IV.

NRC 1.36 – Nuclear Regulatory Commission Guide 1.36 Non-Metallic Thermal Insulation

NFPA 90A

NFPA 255

UL 723 – Composite Surface Burning Characteristic

CAN ULC S102-M

MIL – I – 22344D – Insulation, Pipe, Thermal, Fibrous Glass

MIL – I – 24244C (Ships)

USCG 164.109 – Non-Combustible Materials

New York City MEA

GreenGuard Certified for Indoor Air Quality

GreenGuard Certified for Children and Schools

1.5 DEFINITIONS

A. Exposed Location: Exposed in mechanical rooms, rooms with finished walls or ceilings, and pipe chase between toilet rooms and equipment rooms.

B. Concealed Location: Located in furred spaces, attics, crawl spaces, above suspended ceilings in finished or unfinished rooms, or all other locations not exposed to view.

C. Cold Piping: Shall include domestic water and other piping with surface temperatures less than 70□F.

D. Hot Piping: Domestic hot water, supply and return and other piping with surface temperatures greater than 105°F.

E. Exterior Locations: All locations exposed, unexposed above grade or below grade beyond the building floor, wall or roof line of the structure or building.

F. Location and Insulation Requirements:

1. Cold Water, including Non-potable Water (NPW): Insulate as follows:

a) All piping above ceilings and in walls.

b) Entire system except for stubouts to fixtures.

2. Domestic Hot: Insulate as follows:

a) Entire system except for stubouts to fixtures.

3. Chilled Water Supply and Return and Heating Water Supply and Return:

a) All piping above ceilings, drops in wall and in mechanical rooms.

4. Roof drains and overflows:

a) All piping in building, ceilings, walls

5. K Factors: All K Factors shown in this Specification are expressed in BTU-in/hr.-ft^2-F.

6. Steam and Condensate Piping

    a) Entire System

1.6 SUBMITTALS

A. Comply with Section 220500.

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

C. Manufacturer's Installation Instructions: Indicate procedures, which ensures acceptable workmanship and installation standards will be achieved.

1.7 QUALITY ASSURANCE

A. Qualifications of Applicator: Company specializing in piping insulation application with five (5) years minimum experience.

B. Regulatory Requirements Fire Hazard Classification: Insulation shall have a composite (insulation, jacket or facing, and adhesive to secure jacket or facing) fire hazard rating as tested by ASTM E-84, NFPA 255, and UL 723 not to exceed 25 flame spread, 50 fuel contribution, and 50 smoke developed. Materials shall be labeled accordingly.

1.8 DELIVERY, STORAGE AND HANDLING

A. Compliance: Comply with Section 230500. Deliver materials to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness and store in a warm, dry location.

1.9 PROJECT/SITE CONDITIONS

A. Storage Environment: Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation while in storage.

B. Environmental Requirements: Perform work at ambient and equipment temperatures as recommended by the insulation manufacturer.

C. Protection: Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Repair or replace any such insulation or covering damaged prior to final acceptance of work.

D. Application Surfaces: Surface shall be dry, free of dust, oil, construction residues or other foreign materials before insulation is applied. Piping joints shall be dry, leak free and tested before application of insulation occurs.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Owens-Corning
2. Knauf
3. Johns Manville
4. Industrial Insulation Group

2.2 MATERIALS

A. Glass Fiber:

1. Insulation: ASTM C547; rigid molded, noncombustible.
   a) 'K' value: ASTM C335, 0.24 at 75 °F
      i) K values shall conform to the following at 75°F
         (a) Heating water to 250°F: .28
         (b) Heater water and Steam to 350°F or above: .32
         (c) Chilled water 40°F to 55°F: .24
         (d) Domestic water 105°F or greater: .24
   b) Minimum Service Temperature: -20°F
   c) Maximum Service Temperature: +450°F
   d) Maximum Moisture Absorption: 0.2 percent by volume

2. Vapor Barrier Jacket:

    a) All Service Vapor Retarder Jacket

    b) Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.

    c) Secure with self sealing longitudinal laps and butt strips.

    d) Alternate: Paper Free All Service Vapor Retarder Jacket

2.3 JACKETS

A. A.PVC Plastic

1. Jacket: ASTM C921, one piece molded type fitting covers and sheet material, off white color.

    a) Minimum Service Temperature: -40°F

    b) Maximum Service Temperature: +150°F

    c) Moisture Vapor Transmission: ASTM E96; 0.002 percent by volume

    d) Maximum Flame Spread: ASTM E84: 25.

    e) Maximum Smoke Developed: ASTM E84; 50

    f) Thickness: 20 mil.

    g) Connections: Brush on welding adhesive

2. Covering Adhesive Mastic: Compatible with insulation

3. Acceptable Manufacturers

    a) Proto

    b) Zeston

    c) Speedline

B. Canvas Jacket; UL listed.

1. Fabric: ASTM C921, 6 oz/sq yd, plain weave cotton treated with dilute fire-retardant lagging adhesive.

2. Lagging Adhesive: Compatible with insulation.

3. Aluminum Jacket: ASTM B209.

   a) Thickness: 20 mil inch sheet.

   b) Finish: Smooth.

   c) Joining: Longitudinal slip joints with 2-inch laps.

   d) Fittings: 0.016-inch-thick die shaped covers with factory attached protective liners.

   e) Metal Jacket Bands: 3/8 inch wide; 0.015-inch-thick aluminum.

C. Aluminum Jacket: ASTM B209

1. Thickness: 0.016-inch sheet.

2. Finish: Smooth

3. Joining: Longitudinal slip joints and 2-inch laps.

4. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.

5. Metal Jacket Bands: 3/8 inch wide; 0.015-inch-thick aluminum.

D. Stainless Steel Jacket: Type 304 stainless steel.

1. Thickness: 0.016 inch

2. Finish: Smooth

3. Metal Jacket Bands: 3/8 inch wide; 0.016-inch-thick stainless steel.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Inspect work in conformance with Section 220500.

3.2 PREPARATION

A. Pipe Testing: Testing of piping shall be completed, and leaks repaired prior to application of insulation. Surfaces shall be clean and dry before proceeding.

B. Installation: Install materials after piping has been tested and approved. See Section 220500.

C. Surface Cleaning: Clean surfaces for adhesives.

3.3 INSTALLATION

A. Pipe Insulation:

1. Manufacturer's Instructions: Install materials according to manufacturer's instructions.

2. Finished Surface Temperature: Insulation thickness shall conform to those recommended ASHRAE 90.1, latest edition, unless otherwise specified. Thickness of insulation shall be sufficient to keep surface temperatures below 115°F.

3. Continuity: Apply insulation tightly over clean, dry surfaces with sections or edges firmly butted together. Make insulation continuous through sleeves or openings in walls and floors.

4. Make insulation continuous at pipe hangers, trapezes, and other types of supports. Do not notch insulation to fit over hangers, trapezes, and other supports. Install shields at all supports.

5. Name Plates: Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

6. Supports: Finish insulation neatly at hangers, supports and other protrusions. Locate insulation or cover seams in least visible locations.

7. Inserts: Provide an insert, not less than 6-inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2-inches diameter or larger, to prevent insulation from compressing at support points. Inserts shall be cork, hardwood or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used with field fabricated insulation value equal to insulation approved by the Project Engineer. Do not use calcium silicate inserts or other material that can absorb moisture on any below ambient piping system.

8. Enclosures: Do not insulate hot water heating pipe within radiation enclosures.

9. Flanges: On insulated piping without vapor barrier and piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation at such locations.

10. Equipment Fittings and Valve Coverings: Insulate all equipment, fittings, and valves. Terminate insulation neatly with insulating and finishing cement troweled on bevel.

11. Preformed Fittings Locations: All fittings and valves shall be insulated with preformed fiberglass for fittings, mitered sections of pipe insulation or fiberglass blanket insulation of equal thickness to the adjacent pipe insulation. Cover the fittings, valves, and insulation with preformed PVC jacket. Close jacket with stainless steel tacks and compatible adhesive.

12. Radiation Barrier: When insulating hot pipe fittings, a layer of kitchen-type aluminum foil shall be applied over the first fiber glass insert applied, making sure the aluminum foil is extended over the adjacent pipe insulation. A second fiber glass insert shall then be applied over the foil with a vapor seal at all the aluminum foil edges. Insulation thickness shall be such that the surface temperature shall not exceed 115°F.

13. Expansion Devices: On insulated piping with vapor barrier; insulate all equipment, fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

14. Fasteners: Avoid the use of staples on vapor barrier jackets. Seal vapor barrier penetrations with white vapor barrier finish and adhesive.

15. Adhesive Limitations: Apply adhesives to not exceed the coverage recommended by the manufacturer.

16. Wall, Floor and Ceiling Penetrations: Continue insulation with vapor barrier through penetrations including walls, floors, and ceilings.

17. Enclosure: All insulation ends shall be firmly butted and secured with minimum 3-inch-wide butt strips. Exposed end of pipe insulation shall be sealed with vapor barrier mastic.

18. Repairs: Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

19. Service Access: When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

20. Unless pre-insulated pipe is used, all insulation below grade shall be polyurethane spray foam covering suitable for use in wet environments without degradation. Piping shall be supported by a rigid Styrofoam board 4 inch thick which exceeds the width of the pipes laid in the trench parallel to the pipe. All pipes shall be wrapped with two wraps of 1 1/2-inch-thick fiberglass blanket before spraying. Spray foam shall be applied to assure a 2-inch MINIMUM coverage. Insulation shall be coated with Deer-O Foam Cap W-256 applied at the rate of one gallon per 100 square ft. or vapor barrier protection with a perm rating of 0.0019.

21. A complete moisture and vapor seal shall be provided on cold surfaces where vapor barrier jackets or coatings are required. Anchors, hangers, and other projections shall be insulated, and vapor sealed to prevent condensation. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

22. Insulation shall be installed in a workmanlike manner by workmen regularly engaged in this type of work. Insulation shall not be applied until all surfaces are clean and dry and until inspection and release for insulation application.

    a) Do not notch insulation to fit around trapezes or wall-mounts fabricated from slotted metal framing ("unistrut or equal"), angle iron or other materials. Insulation shall be continuous across the support and an insulation shield shall be installed to prevent crushing the insulation. Pipe clamps shall be sized to fit around insulation and shield.

    b) Insulation may be notched or trimmed around riser clamps. Seal exposed insulation.

B. Jackets:

1. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish fittings, joints, and valves with pre-molded PVC jackets secured with stainless steel tacks. The precut insulation shall be held in place by copper wire or hemp twine and be removable without damage to the insulation or jacket. Leave surfaces clean and ready for painting.

2. Indoor, Concealed Applications: Insulated dual-temperature pipes or pipes conveying fluids below ambient temperature shall have vapor barrier jackets, factory-applied or field-applied. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with pre-molded PVC jackets.

3. Indoor, Exposed Applications: Mechanical Equipment Rooms, all insulated piping to be finished with aluminum jacket secured with metal jacket bands.

4. Indoor, Exposed Applications: Same as Indoor, Concealed Applications except that in addition the insulation shall be covered with an aluminum jacket secured with metal jacket bands.

5. Exterior Applications: Same as Indoor, Exposed Applications plus connect with a modified S lock equal to Premetco "Loc-Jack" Z-Crimp, Factory or Field installed. All seams shall be sealed with silicone caulking and have seams oriented so that the jacketing will shed water & not tend to trap and enter rainwater.

3.4 APPLICATION

A. Fittings and Valves Insulation:

1. Pre-molded Fittings: All insulated pipe fittings shall be insulated with 20 mil PVC Zeston one-piece pre-molded insulated fittings wherever possible. If Zeston fittings are not available for the use required, comply with the following paragraph #2. Insulate fittings with fiberglass tightly wrapped with copper wire or heavy hemp twine to within 1/4 inch of thickness of adjoining copper wire or insulation, finished with 1/4 inch of insulating cement troweled flush with pipe insulation. A tack coat of mastic vapor barrier Foster 60-25 or 26-to-1/16-inch thickness or equal shall be applied to fittings and valves. Apply 6 oz. fiberglass canvas jacket to build-up (not PVC) fitting band valve insulation. Cement laps thoroughly with Foster 81-42 or 30-36 adhesive.

B. Perm Rating Vapor Barrier Mastic Coatings:

1. Perm rating not more than 0.25 when tested in accordance with ASTM E-96, Procedure A Fire Retardant.

C. Adhesives, Sealers, Facings, and Vapor Barrier Coatings:

1. Compatible with materials to which applied, and shall not corrode, soften, or otherwise attach the pipe or insulation materials in either the wet or dry state. Use only adhesives, sealers, facings, and vapor barrier coatings recommended by the approved manufacturers of insulation materials.

3.5 SCHEDULE

Service	Pipe Size	Thickness
CW, HW, HWC	All sizes CW, 1/2 inch to 1-1/4-inch HW, HWC	1 inch
	1-1/2 inch and Larger HW, HWC	1-1/2 inch
NPW & Cooling Condensate	All sizes	1 inch
RD & OF	All sizes	1 inch

END OF SECTION 22 07 00

SECTION 22 10 00 - PIPE AND PIPE FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 SCOPE

A. This section of the specifications encompasses the basic materials and methods of the various piping systems covered in Division 25.

B. Standards: The latest edition of each standard referenced shall be used to determine compliance.

1.3 RELATED WORK IN OTHER SECTIONS

220000	PLUMBING INDEX
220500	GENERAL PLUMBING REQUIREMENTS
220523	VALVES
220700	PIPING INSULATION
221113	DOMESTIC WATER SYSTEMS
221123	NATURAL GAS PIPING SYSTEMS
221313	SOIL AND WASTE PIPING SYSTEMS
230548	VIBRATION ISOLATION AND EXPANSION COMPENSATION

1.4 IDENTIFICATION OF PIPING

A. All accessible piping shall be labeled at not more than 10 ft. intervals with labels indicating the service and direction of flow. Pipe labels shall be self-adhesive labels, all-temperature Perma-Code pipe markers No. B-500, manufactured by the W.H. Brady Company. The background color code for all markers shall conform to the American National Standard A13.1 - 1975 "Scheme for the Identification of Piping Systems."

B. The color red shall be for the exclusive use on fire protection service piping and sprinkler piping per OSHA regulations (CFR 1910.144).

PART 2 – PRODUCTS

2.1 PIPING SYSTEMS

A. Domestic water system

1. Above grade:

a) Copper: Shall be Type K soft drawn, or Type L hard drawn, seamless copper tubing conforming to ASTM B88, with wrought copper and bronze solder joint pressure fittings conforming to ANSI B16.22.

2. Underground:

a) Copper: Type K hard, seamless copper tubing conforming to ASTM B-88 with silver brazed joints (ASTM B-260 Class BAg-1) with wrought copper fittings per ANSI B16.22.

B. Soil and waste system

1. Above ground:

a) Cast Iron: Shall be cast iron hub and spigot soil pipe or hubless cast iron pipe and fittings, (No-Hub Couplings shall conform to CISPI Standard 310 & ASTM A-1277 or latest edition) conforming to ASTM A74 (latest edition) and/or Cast-Iron Soil Pipe Institute (CISPI) CS-888 and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. The hub and spigot pipe shall use compression gasket joints per ASTM C-564 & ASTM 1563.

2. Underground inside building:

a) Cast Iron: Shall be cast iron hub and spigot soil pipe or hubless cast iron pipe and fittings, (No-Hub Couplings shall conform to CISPI Standard 310 & ASTM A-1277 or latest edition) conforming to ASTM A74 (latest edition) and/or Cast-Iron Soil Pipe Institute (CISPI) CS-888 and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. The hub and spigot pipe shall use compression gasket joints per ASTM C-564 & ASTM 1563.

3. Underground outside buildings:

a) Under traffic areas and parking lots: Shall be cast iron hub and spigot soil pipe conforming to ASTM A74 and Cast-Iron Institute CISPI 301.

b) All other areas: Piping shall be polyvinylchloride (schedule 40 for size 4" and smaller, SDR-35 for sizes 6" and larger), exterior sewer pipe (PVC) ASTM D3034 with gaskets per ASTM D1869.

c) Risers and base fittings for grade cleanouts shall be extra heavy cast iron pipe and fittings with compression joints per ASTM C-564 & ASTM-1563.

4. Manholes:

a) Manholes shall be of either precast or brick construction. Precast shall be 48" diameter, Class II, Type V reinforced concrete per ASTM C-478. Top section shall be built to grade with brick or concrete grade rings. Brick manholes shall be constructed to the standard and with approval of local jurisdiction authorities.

b) Frame and covers shall consist of grey iron, ASTM Class 45 with lid indexed "Sanitary Sewer" or "Storm Sewer" as applicable. Frame and cover shall be Neenah Foundry Company model R-1370 with Type C lid or equal.

C. Sanitary vent system

1. Vent piping 2" and smaller in diameter may be schedule 40 galvanized steel pipe conforming to ASTM A-53 with 150 pound galvanized malleable iron screwed fittings conforming with ANSI B16.3. Vent piping larger than 2" shall be cast iron as specified for interior soil and waste.

D. Refrigeration piping system

1. COPPER: Shall be "ACR" Type L hard drawn, seamless copper tubing conforming to ASTM B280, with wrought copper and bronze solder joint pressure fittings conforming to ANSI B16.22.

E. Roof drain system

1. The roof drain system shall be the same as the soil and waste system except that for drains 2" and smaller in diameter, Schedule 40 galvanized steel pipe conforming to ASTM A-53 with 150-pound galvanized malleable iron screwed fittings conforming with ANSI B16.3, may be used.

F. Natural gas piping system

1. Black steel: Above grade piping shall be Schedule 40, black steel pipe conforming to ASTM A-53, with 150-pound malleable iron screwed fittings conforming with ANSI B16.3. or seamless carbon steel weld fittings conform to ASTM A-234.

2. Underground piping shall be schedule 40 black steel pipe conforming to ASTM A-53 machine wrapped with Scotchwrap PVC tape using 50% overlap. Fittings and joints shall be double wrapped to a minimum 6 inches beyond the fitting. Pipe shall be primed prior to wrapping per manufacturer's recommendations.

G. Compressed air piping systems

1. Copper: Shall be Type L hard drawn, seamless copper tubing conforming to ASTM B88, with wrought copper, fittings or bronze solder joint pressure fittings conforming to ANSI B16.22-63.

2.2 JOINTS

A. Copper:

1. Silver brazed joints shall use brazing material containing approximately 45% silver, 15% zinc, 25% cadmium and 15% copper. Joints shall conform to ASTM B-260 Class BAg-1.

Approved materials include Mueller #122, Lucas Milhaupt "Easy Flo45" and United Wire and Supply "Sil-Bond 45".

B. Cast Iron:

1. Neoprene Rubber gaskets for hub and spigot piping per ASTM C564.

2. No hub joints shall consist of couplings that conform to CISPI 301.

C. Ductile Iron: Joints shall be of the stuffing box type per ANSI 21.11 as modified by ANSI 21.51 or push-on type per ANSI 21.51. Rubber gaskets and lubricant shall be per ANSI 21.11.

D. Black Steel:

1. Screwed joints shall be made with no more than three threads showing using teflon tape or teflon joint sealing compound.

2. Welded joints shall be fusion welded to full metal depth with width at least 2 1/2 times the depth of the metal being joined.

E. Galvanized Steel:

1. Screwed joints shall be made with no more than three threads showing using teflon tape or teflon joint sealing compound.

F. Bell and spigot joints shall conform to AWWA C200 with rubber gaskets.

G. Bonded joints shall have metallic bond including joints made with flexible couplings, caulking or rubber gaskets. Metallic bond shall be of ferrous material to effect continuous conductivity. Bond wire shall be type RHW-USE, size 1/0 neoprene gasketed copper conductor. Bond shall be thermal weld type.

H. Insulating joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe. Insulating joints shall consist of a sandwich type flange insulating gasket of the dielectric type, insulating washers, and insulating sleeves for flange bolts. Gaskets shall be full faced. Bolt insulating sleeves shall be full length. Units shall be of a construction to prevent metal to metal contact of dissimilar piping materials.

2.3 FLOOR, WALL, AND CEILING PLATES

A. Where exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass flanges or flanges to match the type of pipe or pipe finish used. Plates shall be large enough to completely close the hole around the pipe and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.4 UNIONS

A. Piping 2-1/2" and larger to have bolted flange unions with gaskets of material suitable for the specified service. Ground joint unions with brass to iron seats shall be used in piping 2" and smaller. Unions shall be installed at all valves and equipment connections.

2.5 HANGERS AND ANCHORS

A. To prevent galvanic action between copper pipe and a dissimilar metal, copper pipe shall be isolated to prevent the pipe from contacting the dissimilar metal. This may be accomplished by mounting the pipe in an isolation fitting, or by wrapping the pipe with a 20-mil thickness of UPC-rated isolation tape. The 20-mil thickness can be accomplished by using a single wrap of 20-mil tape or by using 10-mil tape with a 50% overlap.

B. Copper pipe does not need to be isolated from copper plated pipe hangers that are suspended from hanger rods.

C. Copper pipe mounted on slotted metal framing ("unistrut or equal"), angle iron, or other dissimilar metal support shall be isolated as described above, even if pipe clamps used are copper plated. Painted, epoxy or powder-coated finishes on the metal support are not an acceptable means of isolation.

D. All piping shall be rigidly supported from the building structure by means of adjustable ring type hangers. Where pipes run side by side, support on rod and angle trapeze hangers. Hangers shall be spaced not greater than 5 feet on centers for cast iron piping, 6 feet on centers for copper piping and 10 feet on centers for steel piping. Plastic pipe shall be supported on not more than 3 feet centers. Round rods supporting the pipe hangers shall be of the following dimensions:

1. 1/2 inch to 2-inch pipe	3/8-inch rod
2. 2-1/2" inch to 3-inch pipe	1/2-inch rod
3. 4-inch to 5-inch pipe	5/8-inch rod
4. 6-inch pipe	3/4-inch rod
5. 8-inch pipe	7/8-inch rod

E. Rods for trapeze hangers shall be a minimum of 3/4-inch and shall have the equivalent cross section listed above per pipe supported. The use of pipe hoods, chains, or perforated iron for pipe supports will not be permitted. Insulated piping shall have hangers outside of insulation with 18 ga. protection sleeves 12" long. Anchors and guides shall be as detailed on the drawings. The Contractor shall provide inserts in the building construction at the time the concrete is poured, and the hangers shall be attached to these inserts. Where inserts cannot be used expansion shields may be used provided the hanger is not attached rigidly to the bolt but is supported from an angle held in place by the expansion bolt. The use of expansion shields must be approved by the Architect/Engineer. See drawings and details for support of tunnel piping.

F. Hanger rods for all equipment, pipes, ducts, trapezes, vibration isolators, etc., shall be installed straight, true, and plumb. Do not bend or flex hanger rods to accommodate sloping structures,

avoid obstacles, or for any other purpose. Where necessary, utilize swivel beam clamps, beveled or swivel hardware, angled, swivel or hinged brackets spanning members or other appropriate means of connection.

2.6 THRUST BLOCKS

A. All underground water line tees, crosses, bends and valves shall be provided with concrete blocking. Concrete blocking shall be used for cast-iron or vitrified clay tile fittings where a change of flow direction occurs. All fittings at bends in the pipeline shall be firmly wedged against the vertical face of the trench by means of concrete thrust blocks bearing on undisturbed earth, to prevent the fittings from being blown off the line when under pressure. Fittings at vertical bends downward shall be anchored with concrete anchors as required. Thrusts blocks shall be determined using an allowable soil bearing pressure of 1,500 PSF at 200 psi test pressure in water line. No blocking will be covered or backfilled until inspected and approved by the Architect/Engineer.

2.7 VALVE BOXES

A. Valve boxes shall be of cast iron extension type with flared base and shall be M & H Valve and Fittings Company, two-piece, 5 1/4" shaft, screw type to fit depth of bury. The minimum thickness of metal shall 3/16" and the nominal diameter of the box shall be at least four inches. The cover shall have the name of the utility service cast in the metal. Boxes shall be installed over each outside gate valve unless otherwise shown on the drawings. The boxes shall be of such length as will provide without extension a cover of not less than three feet over all water pipes. Valve boxes shall have concrete collars.

PART 3 – EXECUTION

3.1 GENERAL

A. Provide and erect in a workmanlike manner according to the best practices of the trade all piping shown on drawings and required for the complete installation of the systems. The piping shown on the drawings shall be considered as diagrammatic for clarity in indicating the general run and connections and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered, or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications and approved by the Architect/Engineer.

B. In the erection of all piping, it shall be properly supported, and proper provisions shall be made for expansion, contraction, and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing or forcing, properly clearing equipment and all windows, door, and other openings. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings.

C. Preinsulated Piping Systems

1. All piping adjoining this system shall be anchored at or near the point of connection to avoid imposing any external forces on the carrier pipe. The Contractor shall pour concrete anchor blocks at every change of direction after testing the pipe. The anchor blocks are to be sized in accordance with forces resulting from thermal stress, existing soil conditions, and shall be in accordance with the manufacturer's recommendations.

2. Immediately after the system is installed in the ditch, a partial backfill of selected earth shall be made in the middle of each unit, leaving the joints exposed for inspection of the hydrostatic test. A hydrostatic test of 200-psig shall be required for a period of four hours. No leakage shall be allowed.

3. After hydrostatic testing, final backfill of selected earth shall be hand placed and hand tamped to 12" minimum over the top of the jacket. Remainder of the backfill shall be free of large boulders, rocks over 6" in diameter, frozen earth, or foreign matter. The backfill operation shall now be completed by any convenient means. Do not use wheeled or tracked vehicles for tamping.

4. The services of a factory-trained Field Service Instructor shall be required, and materials shall be stored, handled, and installed in accordance with Manufacturer's recommendations. The Field Service Instructor shall be present during critical stages of the installation and testing.

D. All open ends of pipes and equipment shall be properly capped or plugged with plugs manufactured for this purpose to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging.

E. All piping shall be arranged avoiding interference with removal and maintenance of equipment, filters, or devices; and not blocking access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided at the piping connections to all items of equipment.

F. Valves and specialties shall be placed to permit easy operation and access, and valves shall be regulated, packed, and adjusted at the completion of the work before final acceptance.

G. All piping shall be erected to insure proper draining. Steam mains shall be pitched down in the direction of flow, a minimum of one inch per 40 feet or appropriately trapped. Where steam and condensate flow in opposite directions within the same pipe, the pipe shall be 2 sizes larger than shown unless specifically shown on the drawings that counterflow of condensate was intended by the design. Condensate return mains shall be pitched down in the direction of flow, one inch per 20 feet. Domestic water piping may be run level but shall be free from traps.

H. Soil and waste piping and other gravity drains shall be sloped down in direction of flow minimum one inch in 20 feet.

3.2 ACCESS DOORS

A. Furnish all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of the work dictates shall be borne by this Mechanical Contractor.

B. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, or Style C-CF for sidewall drywall or plaster construction.

3.3 JOINTS

A. Resilient molded gaskets shall be used on hub and spigot piping. For cast iron soil pipe not located under buildings, the Contractor may also use the No-hub sanitary system for pipe 6" and below with neoprene sealing gaskets, stainless steel retaining sleeves and two draw bands. An adequate torque wrench shall be used for system installation in accordance with manufacturer's recommendations.

B. Screwed Joints: Screwed joints shall be American Standard taper pipe threads. Ream pipe ends and remove burrs after threading. Make up joints using an approved compound or teflon tape, applied to the male threads only.

C. Brazed and Soldered Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections.

D. Welded Joints: On black steel piping 2 inches and above in size, the joints shall be welded. Welding shall be done using either gas or electric welding equipment. Certified welders shall be used. All pipe surfaces shall be thoroughly cleaned before welding. Each joint shall be beveled before being welded. Piping shall be securely aligned and spaced, and the width of circumferential welds shall form a gradual increase in thickness from the outside surface to the center of the weld. The Contractor shall use appropriate materials to protect the structure and provide adequate fire protection at all locations where welding is done. All elbows shall be long radius unless otherwise specified. Wherever tee connections are made to piping systems on the main run, welding sockets may be installed for the branch connections up to one half the size of the main run. On connections larger than one half the size of the main run, welding tees shall be used. The use of fittings formed from welded pipe sections will not be permitted.

E. Flanged Joints:

1. Cast iron flanges shall conform to the American Standard for cast iron pipe flanged fittings, Class 125 (B.16.1). Gaskets shall be suitable for the service on which used.

2. Steel flanges shall be 150 lb. raised face type.

F. Solvent Welded Joints:

1. Pipe shall be cut square with pipe cutters designed specifically for plastic pipe. Pipe shall be protected from serrated holding devices and abrasion. Remove burrs from inside and outside of pipe. Clean the joining surfaces using an approved ABS Cleaning compound. Following the instructions on the can, apply the ABS cement and assemble the joint as quickly as possible before the cement dries.

3.4 PUMP AND EQUIPMENT CONNECTIONS

A. All piping connecting to pumps or other equipment shall be installed with isolation valves and flexible connections to prevent strain at the connection to equipment. The Contractor shall be required as directed to disconnect piping to demonstrate that piping has been so connected. Provide a suction diffuser at each end suction pump where the inlet piping has a straight run of less than 15 pipe diameters in length. Suction diffusers shall consist of angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16-inch diameter openings for pump protection. Strainer free area shall be five times the section area of the pump connection. Provide an adjustable support foot for diffusers installed on end suction pumps.

3.5 PIPE SLEEVES

A. Pipe sleeves shall be furnished and set by the Contractor, and the Contractor shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs unless so noted on the drawings or with the consent of the Architect/Engineer. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through concrete or masonry construction and through all exterior walls, regardless of construction. Pipe sleeves, except sleeves in footings and beams shall be of sufficient diameter to provide approximately 1/4-inch clearance around the pipe, and in cases of insulated pipes, approximately 1/4-inch around the insulation. Pipe sleeves in footings and beams and exterior walls shall be of steel pipe. Sleeves in footings shall be not less than one inch or more than two inches larger in diameter than the pipe to be installed. Pipe sleeves in floors shall be cut flush with finished floor. Openings between piping and sleeves shall be made watertight with plastic cement to a minimum depth of two inches. Openings between piping and sleeves in all masonry or concrete interior walls and partitions shall be similarly caulked for acoustical reasons.

3.6 EXPANSION AND CONTRACTION

A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors to prevent undue strain.

3.7 PROTECTIVE COATINGS

A. All underground pipe except exterior cast iron water distribution pipe shall be wrapped with "Scotchwrap" No. 50 tape to give not less than two complete layers on the entire underground piping system, or piping shall have X-TRU Coat factory applied plastic protective covering.

B. All buried exterior cast iron water distribution piping shall be tar coated.

3.8 TESTING

A. Before any insulation is installed or before piping is covered or enclosed all piping systems shall be tested and proved tight at not less than 1 1/2 times the maximum service pressure which the piping systems will be required to handle, unless otherwise specified.

B. All tests shall be conducted in the presence of the Architect/Engineer and the building Owner or his representative. Any systems failing to meet the specified test requirements shall be corrected and retested until the test requirements are met.

3.9 FLUSHING, DRAINING, AND CLEANING PIPE SYSTEMS

A. The Contractor shall flush water piping systems with water before placing them in operation. After systems are in operation and during the test period all strainer screens shall be removed and thoroughly cleaned. The Contractor shall notify the Architect/Engineer in writing when this requirement is to be accomplished.

B. All domestic water lines shall be sterilized as described in Section 221113 -DOMESTIC WATER SYSTEM of these specifications.

END OF SECTION 22 11 00

SECTION 22 11 13 - DOMESTIC WATER SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall furnish and install the Domestic Water System as shown on the drawings including specialties shown or called out in the fixture and/or equipment list and as necessary for satisfactory operation of the system.

1.3 RELATED WORK IN OTHER SECTIONS

220000	PLUMBING INDEX
220500	GENERAL PLUMBING REQUIREMENTS
220523	VALVES
220700	PIPING INSULATION
221000	PIPE AND PIPE FITTINGS

1.4 STERILIZATION

A. All domestic water piping shall be sterilized as described in Part 3 of this section.

PART 2 – PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Pipe and pipefittings shall be as described in Section 221000 - PIPE AND PIPE FITTINGS.

B. All piping in any utilities tunnel shall have welded or silver brazed joints.

2.2 SHOCK ABSORBERS

A. Shock absorbers and/or air cushions shall be installed where shown on the drawings. Shock absorbers shall be equal to Zurn Z-1700, Diatrol Series 500 or approved equal sized for the system being protected.

PART 3 – EXECUTION

3.1 INSTALLATION

A. The installation shall conform to the requirements of Section 220500 - GENERAL PLUMBING REQUIREMENTS, and Section 221000 - PIPE AND PIPE FITTINGS.

B. Insulating couplings shall be furnished and installed at all connections between copper and steel pipe to prevent electrolysis.

C. Each water service main, branch main, riser and branch to a group of fixtures shall be valved. Stop valves shall be provided at each fixture.

3.2 STERILIZATION

A. Domestic Water lines shall be sterilized as follows: Chlorine shall be applied to provide a solution of not less than 250 PPM. The chlorinating material shall be introduced into the waterline in a manner approved by the Architect/Engineer. The solution shall be circulated if provided with pumps and all valves in the line shall be operated several times during the contact period. After a contact period of no less than eight (8) hours the system shall be flushed with clean water until the residual chlorine content is not greater than 0.2 PPM.

B. The sterilization procedure shall be witnessed by the Architect/Engineer and Owner.

3.3 TESTS

A. General: All tests shall be conducted in the presence of the Architect/Engineer or his representative. Any systems failing to meet the specified test requirements shall be corrected and retested until the test requirements are met.

B. Water Systems: The complete water systems shall be hydrostatically tested at a pressure of 150 psi and shall show no loss in pressure for a period of one hour.

END OF SECTION 22 11 13

SECTION 22 11 23 - NATURAL GAS PIPING SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall furnish and install the Natural Gas System as shown on the drawings including specialties necessary for satisfactory operation of the system.

1.3 RELATED WORK IN OTHER SECTIONS

220000	PLUMBING INDEX
220500	GENERAL PLUMBING REQUIREMENTS
220523	VALVES
221000	PIPE AND PIPE FITTINGS

PART 2 – PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Pipe and pipe fittings shall be as described in Section 221000 - PIPE AND PIPE FITTINGS.

B. All underground gas piping shall be welded.

C. Any underground gas piping shall have a protective coating as specified in Section 221000 - PIPE AND PIPE FITTINGS.

D. All gas piping in any utilities tunnel shall be welded.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Furnish and install all piping as indicated on the drawings, and all accessories in strict accordance with the applicable gas code.

B. All gas piping in any utilities tunnel shall be isolated from any metal-to-metal contact with hangers, supports, rails, etc.

C. Ventilated conduit shall be used to carry natural gas piping whenever such piping is run under any building, building sidewalk, structure, or through or within a concealed return air space. Ventilated conduit construction shall conform to the details shown on the drawings.

D. Gas trains connecting gas fired equipment shall conform to UL requirements.

E. All equipment (AHU, AC, Water Heaters, etc.) connected to the gas system shall be connected with gas valve, union, dirt leg with removable cap (up 4" above any surface) and flexible connection.

F. All piping and accessories shall be supported by unistrut brackets and gasketed pipe clamps, inside of the building.

3.2 TESTS

A. All gas piping shall be tested with air pressure of 60 psi and shall show no loss in pressure for a period of 24 hours on a gauge for recording pressure.

END OF SECTION 22 11 23

SECTION 22 13 13 - SOIL AND WASTE PIPING SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall furnish and install the soil and waste piping system as shown on the drawings including specialties shown or called out in the equipment list and as necessary for satisfactory operation of the system.

1.3 RELATED WORK IN OTHER SECTIONS

220000 PLUMBING INDEX
220500 GENERAL PLUMBING REQUIREMENTS
221000 PIPE AND PIPE FITTINGS

1.4 REQUIREMENTS

A. See Sections 220500 - GENERAL PLUMBING REQUIREMENTS and 221000 - PIPE AND PIPE FITTINGS for general requirements.

B. Furnish and install all concrete, grout, and other required materials to fill all block outs and/or sleeves left open for this Subcontractor's convenience or for the installation of this work.

PART 2 – PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. The pipe and pipefittings shall be as described in Section 221000 - PIPE AND PIPE FITTINGS.

2.2 FLOOR DRAINS

A. Drains shall be Zurn, Wade, or Smith and shall be equal to those specified on the drawings.

2.3 FLOOR SINKS

A. Drains shall be Zurn, Wade, or Smith and shall be equal to those specified on the drawings.

2.4 CLEANOUTS

A. Cleanouts shall be as manufactured by Zurn, Wade or Smith and shall be of the same size as the pipe except that cleanout plugs larger than four inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarterbend, or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings.

B. Cleanouts in finish floors shall be of the type made to match the floor and/or covering. All exposed metal shall be polished or chrome plated brass.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation shall conform to Section 220500 - GENERAL PLUMBING REQUIREMENTS, and Section 221000 - PIPE AND PIPE FITTINGS.

B. Flashings: Vent pipes shall be flashed and made watertight at the roof with sheet lead flashing. Flashing shall weigh at least four pounds per square foot, shall be 24 inches square and shall be turned up around the pipe and into the top of the pipe. Vent pipes shall extend at least 12 inches above roof.

C. Traps: Each fixture and piece of equipment connecting to the drainage system shall be equipped with a trap. Each trap shall be placed as near to the fixture as possible and no fixture shall be double trapped.

D. Floor Drains: All floor drains shall be installed with grates square with the building lines.

3.2 TESTS

A. The entire sanitary system shall be tested in accordance with the requirements of the State Plumbing Code, all local codes and ordinances, and the Uniform Plumbing Code.

END OF SECTION 22 13 13

SECTION 22 1313.01 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes sanitary sewerage outside the building.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete structures.

1.03 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.04 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.05 SUBMITTALS

A. Product Data: For Sewer Pipe, Fittings, and Cleanouts to grade.

B. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

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

1. PVC Backwater Valves and Cleanouts:

a. Canplas, Inc.
b. IPS Corp.
c. NDS, Inc.
d. Plastic Oddities, Inc.
e. Sioux Chief Manufacturing Co., Inc.

2.02 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.03 PIPES AND FITTINGS

A. PVC Sewer Pipe and Fittings: According to the following:

1. PVC Sewer Pipe and Fittings, NPS 15 (DN375) and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
a. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794, open and closed profile, bell and spigot for gasketed joints.

1. Gaskets: ASTM F 477, elastomeric seals.

2.04 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.

1. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.

B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.

1. Material for Plastic Pipe: ASTM F 477, elastomeric seal.

2.05 PE FILM, PIPE ENCASEMENT

A. ASTM A 674 or AWWA C105; PE film, tube, or sheet; 8-mil (0.2-mm) thickness.

2.06 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.

2. Fine Aggregate: ASTM C 33, sand.

3. Coarse Aggregate: ASTM C 33, crushed gravel.

4. Water: Potable.

B. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.

2.07 CLEANOUTS

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

3.02 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earthwork." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.03 PIPING APPLICATIONS

A. General: Include watertight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Gravity-Flow Piping: Use the following:

1. NPS 4 and NPS 6 (DN100 and DN150): PVC sewer pipe and fittings, solvent-cemented joints or gaskets and gasketed joints..

3.04 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for non-pressure applications:

a. Sleeve type to join piping, of same size, or with small difference in OD.

b. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Special Pipe Fittings: Use where indicated. Include PE film, pipe encasement.

3.05 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

1. Install piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.

2. Install piping with 36-inch minimum cover.

F. Extend sanitary sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

3.06 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Refer to Division 2 Section "Utility Materials" for basic piping joint construction and installation.

C. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: With rubber gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.

1. Install PE film, pipe encasement over hub-and-spigot, cast-iron soil pipe and fittings according to ASTM A 674 or AWWA C105.

D. Hubless Cast-Iron Soil Pipe and Fittings: With CISPI-type couplings according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

1. Install PE film, pipe encasement over hubless cast-iron soil pipe and fittings according to ASTM A 674 or AWWA C105.

E. Hubless Cast-Iron Soil Pipe and Fittings: With heavy-duty-type couplings according to CISPI 310, CISPI's "Cast Iron Soil Pipe and Fittings Handbook," and coupling manufacturer's written instructions.

1. Install PE film, pipe encasement over hubless cast-iron soil pipe and fittings according to ASTM A 674 or AWWA 105.

F. PVC Sewer Pipe and Fittings: As follows:

1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.

2. Join profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.

3. Install according to ASTM D 2321.

G. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

H. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

I. Install with top surfaces of components, except piping, flush with finished surface.

3.07 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.08 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.09 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.

B. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

C. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.10 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. Place plug in end of incomplete piping at end of day and when work stops.

2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with 24 hours (min.) advance notice.
4. Submit separate reports for each test.
5. If authorities having jurisdiction do not have published procedures, perform tests as follows:
   a. Sanitary Sewerage: Perform hydrostatic test.
      1) Allowable leakage is maximum of 50 gal. per inch of nominal pipe size per mile of pipe, during 24-hour period.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.
      6) Option: Test ductile-iron piping according to AWWA C600, Section "Hydrostatic Testing." Use test pressure of at least 10 psig.
   b. Sanitary Sewerage: Perform air test according to UNI-B-6.
      1) Option: Test concrete piping according to ASTM C 924.
6. Leaks and loss in test pressure constitute defects that must be repaired.
7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 22 13 13

SECTION 22 42 00 - PLUMBING FIXTURES

PART 1 – GENERAL

1.1 SCOPE

A. Plumbing fixtures shall be supplied, set, and connected as shown on plans. Fixtures shall be protected from damage during construction and shall be thoroughly cleaned of all tape, paint, and adhesive prior to final acceptance.

PART 2 – PRODUCTS

2.1 PLUMBING FIXTURES

A. Plumbing fixtures shall be as manufactured by KOHLER, AMERICAN STANDARD, or SLOAN and shall be as scheduled on the drawings.

B. Flush valves shall be as manufactured by Zurn, Delany, or Sloan.

2.2 FITTINGS AND PIPES

A. Fittings and piping shall be brass and whenever exposed, shall be polished chrome-plated. Provide tight fitting wall and/or floor escutcheons of chrome-plated brass whenever pipes pass through floors, wall, or ceilings.

B. All porcelain or vitreous china shall be clean, smooth, and bright. All shall be warranted not to craze, discolor, or scale.

C. This contractor shall furnish and install all required water, waste, soil, and vent connections to all plumbing fixtures together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.

D. All automatic or self-closing valves for faucets shall be adjusted in accordance with manufacturer's instructions and supervised as necessary by equipment supplier's representative at the request of the Architect or Engineer.

E. Owner furnished equipment shall be connected with drains, traps, hot water, cold water and other services required for optimum operation. This contractor shall obtain information from the Owner or his approved representative for services required or field verify specific requirements.

END OF SECTION 22 42 00

SECTION 23 00 00 - HEATING, VENTILATING, AND AIR CONDITIONING INDEX

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Furnish all service tools, equipment, etc., which are required for the complete installation of all Heating, Ventilating, and Air Conditioning Work, as indicated on the Drawings and specified herein. Heating, Ventilating, And Air Conditioning work indicated on the Drawings and/or specifications covering other trades shall conform to Division 23 of these Specifications.

B. Work or equipment not indicated or specified, which is necessary for the complete and proper operation of the Heating, Ventilating, And Air Conditioning systems, shall be accomplished without additional cost to the Owner.

C. Furnish all labor and materials required for Heating, Ventilating, and Air Conditioning service connections to all the various items of equipment requiring connection throughout the project shown on the Contract Drawings (even if not shown on Heating, Ventilating, and Air Conditioning Drawings). Coordinate with other trades for the installation of required connections and service.

1.3 HEATING, VENTILATING, AND AIR CONDITIONING DIVISION INDEX

PART 2 – PRODUCTS: Not used.

PART 3 – EXECUTION: Not used.

END OF SECTION 23 00 00

SECTION 23 01 00 - DEMONSTRATION AND TRAINING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. After completion of the installation and upon completion of the Test and Balancing, the Contractor shall schedule the System Demonstration, Operating Test, and Training Session for the Owner.

B. The following individuals, companies or representatives thereof shall be in attendance.

1. Mechanical Trade

2. Electrical Trade

3. Sheet Metal Trade

4. Controls Trade

5. Energy Management Systems Contractor

6. Test and Balance Agency

7. Air Handler Manufacturer

8. Fan Coil Manufacturer

9. Pump Manufacturer

1.3 RELATED WORK IN OTHER SECTIONS

230000	HEATING, VENTILATING AND AIR CONDITIONING INDEX
230500	GENERAL HEATING, VENTILATING, AND AIR CONDITIONING REQUIREMENTS
230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230548	BALANCING MECHANICAL SYSTEMS

1.4 QUALIFICATIONS

A. The representatives listed in 1.2B above shall be thoroughly familiar with the operation and function of the equipment or systems he represents and be prepared to indoctrinate the Owner or his designated personnel.

PART 2 – PRODUCTS

2.2 SCHEDULE

A. The Contractor shall schedule and coordinate the System Demonstration and Training Session for the Owner over 1 consecutive 8 hour working day.

B. The Owner may, after the training session has started:

1. Excuse the equipment manufacturer when his indoctrination session is completed.

2. Conclude the session early if he feels the intent and purpose of the session has been met.

2.3 ADJUSTMENTS

A. The Contractor shall have available, tools, equipment, and personnel to readjust or refine the operation of any part of the mechanical system as directed by the Owner or Architect/Engineer.

PART 3 – EXECUTION

3.1 TRAINING

A. The Contractor shall schedule and coordinate the indoctrination of the Owner and his designated personnel during the Operating Test. The proposed time schedule shall be coordinated with the individuals, companies or representatives who will be conducting the indoctrination and training. This proposed time schedule shall be submitted to the Architect/Engineer for approval.

B. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and system at agreed upon times.

C. For equipment requiring seasonal operation, perform instructions for other seasons within six (6) months.

1. Contractor shall provide a minimum of eight (8) hours of training for seasonal system operation.

2. Contractor shall prepare a written report of training and submit to architect upon completion of training.

D. Use operation and maintenance manuals as a basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

E. Prepare and insert additional data in Operation and Maintenance manual when need for such data become apparent during instruction.

3.2 TRAINING

A. The Contractor shall schedule and coordinate the indoctrination of the Owner and his designated personnel during the Operating Test. The proposed time schedule shall be coordinated with the individuals, companies or representatives who will be conducting the indoctrination and training. This proposed time schedule shall be submitted to the Architect/Engineer for approval.

3.3 DOCUMENTATION

A. The Contractor shall prepare an indoctrination schedule similar to the following:

INDOCTRINATION SCHEDULE:
PROJECT:
LOCATION:

PERSONNEL	ITEM/SYSTEM	DATE	START TIME	STOP TIME

B. The Owner shall initial each line to verify attendance.

3.4 OPERATING INSTRUCTIONS

A. The operating instructions specified in Sections 230500 and 253000 of these specifications shall be presented at the start of the Session. These instructions shall include manufacturer's published data having all information that does not apply crossed out.

3.5 WATER TREATMENT PROPOSALS

A. Not part of project.

3.6 OPERATING TEST

A. The Contractor shall conduct an operational test on all equipment installed under this Division of the Specifications. This test shall be continuous for a minimum of three consecutive days within seven days prior to the demonstration and training period with required data available at the demonstration and shall continue during the demonstration period. The test shall verify the operation of the mechanical systems and demonstrate the performance of the total system.

B. The following data shall be recorded hourly during normal building occupancy hours.

1. Outdoor ambient temperatures:

a) Measure and record outdoor dry bulb and wet bulb temperature.

b) Calculate and record relative humidity.

2. Indoor space temperature:

a) Measure dry bulb temperature in several rooms served by each air handling unit including at least one room in each control zone. Note any variation over 2`F from setpoint.

b) Measure wet bulb temperature in each space having a space humidistat. Calculate space relative humidity and note any variation over 5% from setpoint.

3. Air Temperatures:

a) Entering and leaving each piece of equipment having air temperature change including:

i) DX refrigeration coils

ii) Air Handling Unit return, OSA and mixed air

iii) Fan coils

iv) Unit Ventilator including return, OSA and mixed air

v) Unit Heater

vi) Base Board Radiation

4. Air Pressure:

a) Building static pressure relative to ambient (outside)

b) Supply static pressure at outlet of each air handling unit

c) Supply static pressure at the end of each duct run

d) Supply static pressure at the inlet of each variable air volume terminal

5. Weather Conditions:

a) Sun

b) Wind velocity

c) Precipitation

d) Barometric pressure

3.7 READINGS AND MEASUREMENTS

A. The Test and Balance Agency shall be available and take any or all readings and measurements required or desired by the Owner or Architect/Engineer during this Demonstration and Training Session.

END OF SECTION 23 01 00

SECTION 23 05 00 - GENERAL HEATING, VENTILATING, AND AIR CONDITIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: General Mechanical Requirements specifically applicable to Division 23 sections in addition to Division 1 - General Requirements.

B. Scope:

1. The work covered by this division consists of performing all operations in connection with the installation of heating, cooling, ventilating, and plumbing including site utility work as indicated under this section. This entire section applies to all mechanical work and all mechanical sections of these specifications. This Contractor shall read and comply with all sections of these specifications including all General and Special Conditions.

1.2 REFERENCES

A. Standard Requirements:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. All work shall be executed in accordance with the local and state codes, ordinances, and regulations governing the particular class of work involved. This Contractor shall be responsible for the final execution of the work under this heading to suit these requirements. In the event of a conflict between the various codes and standards, the more stringent shall govern. Where these specifications and accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect/Engineer. The Architect/Engineer shall prepare any supplementary drawings required, illustrating how the work may be installed so as to comply. On approval of the change by the Architect/Engineer, the Contractor shall install the work in a satisfactory manner without additional cost to the Owner. On completion of the various parts of the work, the installation shall be tested by the constituted authorities and approved, and on completion of the work, this Contractor shall obtain and deliver to the Owner final certificates of acceptance. This Contractor shall furnish copies of each certificate to the Architect/Engineer.

C. The Contractor shall secure all permits and licenses for his work and shall pay all fees in connection with such permits and licenses.

D. The contractor shall hold and save the Owner free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

E. Any and all meter deposits and all utility extension costs shall be paid by the Contractor whose work is done in connection with the service that the meter is connected to.

F. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

1. AABC	Associated Air Balance Council
2. ADC	Air Diffusion Council 435 North Michigan Ave. Chicago, IL 60611
3. AGA	American Gas Association 1515 Wilson Boulevard Arlington, VA 22209
4. AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004
5. ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
6. ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers 345 East 47th Street New York, NY 10017
7. ASME	American Society of Mechanical Engineers 345 East 45th Street New York, NY 10017
8. ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
9. AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
10. AWS	American Welding Society 2501 NW 7th Street Miami, FL 33125
11. FM	Factory Mutual System 1151 Boston-Providence Turnpike Norwood, MA 02062

12. FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Building 197 Washington, DC 20407
13. NBFU	National Board of Fire Underwriters 5530 Wisconsin Avenue, Suite 750 Chevy Chase, Maryland 20815
14. NEC	National Electric Code (of NFPA)
15. NEBB	National Environmental Balancing Bureau 8224 Old Courthouse Road Vienna, VA 22180
16. NEMA	National Electrical Manufacturer's Association 2101 L Street, NW Washington, DC 20037
17. NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
18. NSF	National Sanitation Foundation Box 1468 Ann Arbor, MI 48106
19. OSHA	Occupational Safety and Health Administration U.S. Department of Labor
20. SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 8224 Old Courthouse Road Vienna, VA 22180
21. TIMA	Thermal Insulation Manufacturers Association Technical Services 1420 King Street Alexandria, VA 22314
22. UL	Underwriters Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

G. Underwriters Laboratories Inc. (UL): All materials, appliances, equipment, devices, or appurtenances shall conform to the applicable standards of Underwriters Laboratories Inc., where such standards have been established.

1.3 DRAWINGS

A. Drawings and specifications shall be considered as cooperative, and work or materials called for by one and not mentioned in the other, or vice versa, shall be done and furnished as though treated by both.

B. In the cases of discrepancies in figures, drawings, or specifications, the Architect/Engineer shall be notified immediately, and his decision shall determine the necessary adjustment. Without such decision, said discrepancies shall not be adjusted by the Contractor save only at his expense, and, in case of any settlement or any complication arising from such adjustment to the Contractor, he shall bear all extra expense involved.

C. Should it appear that the work intended to be done, or any of the matters relative thereto, are not sufficiently detailed or explained on the drawings or specifications, the Contractor shall apply to the Architect/Engineer for such further drawings or explanations as may be necessary, allowing a reasonable time for the Architect/Engineer to supply same, and the Contractor shall conform to same as part of the Contract.

D. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, reference shall be made to the Architect\Engineer whose decision shall be final and conclusive. No alleged oral admission, condonation, or inadvertent neglect on the part of the Architect/Engineer will be accepted as an excuse for inferior work.

E. The mechanical plans do not give exact details as to elevations of ductwork and piping, exact locations, etc., and do not show all offsets, control lines, pilot lines, and other installation details. The Contractor shall carefully lay out his work at the site to conform to the structural conditions, provide proper grading of lines, to avoid all obstructions, to conform to details of installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated, satisfactory operational installation.

F. Should the particular equipment which any Bidder proposes to install, require other space conditions than those indicated on the drawings, the Bidder shall arrange for such space with the Architect/Engineer before submitting his bid. Should changes become necessary on account of failure to comply with these details, the Contractor shall make such necessary changes at his (the Contractor's own expense).

G. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans which shall be checked by the Architect/Engineer and approved before the work is started, Contractor before work proceeds. Interference with structural conditions shall be corrected by the Contractor.

H. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

I. Site visit: The Contractor shall visit the site prior to bidding and satisfy himself as the conditions under which the mechanical systems are to be installed. No subsequent allowance shall be made in his behalf for failure to make such a visit. Contractor shall examine all work noted under the demolition drawings and all new work and shall satisfy himself as to the extent of work required to be completed.

1.4 SYSTEM DESCRIPTIONS

A. Not Used.

1.5 PRIOR APPROVALS

A. Each equipment item for which the Contractor desires to install equipment other than the specific item identified in the equipment schedule or equivalent equipment by manufacturers specifically named in the schedule, the Contractor shall bear full responsibility to prove to the Engineer that the furnished equipment is equivalent to or better than the specified item. Failure to provide such proof will result in rejection of the shop drawing submittal by the Engineer. Prior written or verbal approval by the Engineer of equipment by other manufacturers will not relieve the Contractor of responsibility to provide equivalence. Prior approval is not required, however, any prior approval given is intended only to provide preliminary agreement that the alternate manufacturer may make equipment that complies with the specification requirements and not that all equipment manufactured by him is acceptable.

1.6 SHOP DRAWINGS

A. Shop drawings or fully descriptive catalog data shall be submitted by the Contractor for all items of material and equipment furnished and installed under this Contract. This shall include piping, ductwork, mechanical equipment, plumbing equipment, control items, etc. The Contractor shall submit to the Architect/Engineer a sufficient number of copies of all such shop drawings or catalog data to provide him with as many review copies as he may need, plus three (3) copies for retention by the Architect/Engineer. No materials or equipment shall be installed until officially approved by the Architect/Engineer.

B. Before submitting Shop Drawings to the Architect/Engineer for review, the Contractor shall examine them and satisfy himself that they are correctly representative of the material or equipment to which they pertain. The Contractor shall so note these Drawings before submitting them. The Contractor's review of Shop Drawings is not intended to take the place in any way of the official review of the Architect/Engineer, and the Shop Drawings which have not been reviewed by the Architect/Engineer shall not be used in fabrication or installing any work.

C. The review of Shop Drawings or catalog data by the Architect/Engineer shall not relieve the Contractor from responsibility for deviations from the plans and Specifications unless he has, in writing, specifically called attention to such deviations as the time of submission and has obtained the permission of the Architect/Engineer thereon, nor shall it relieve him from the responsibility for error of any kind in Shop Drawings. When the Contractor does call such deviations to the attention of the Architect/Engineer, he shall state in his letter whether or not such deviations involve any extra cost. If this is not mentioned, it will be assumed that no extra cost is involved for making the change.

D. After receiving approval on the make and type of materials, the Contractor shall order such materials in sufficient time so that no delay or changes will be caused. This is done to facilitate progress on the job and failure on the part of the Contractor shall render him liable to stand the expense of any and all delays occasioned by failure on this part to provide necessary details. All shop drawings shall be delivered to the Architect/Engineer's office within thirty (30) days from the date of the contract.

E. Shop drawings will be returned unchecked unless the following information is included: reference to all pertinent data in the Specifications or on the drawings, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings.

1.7 SUBMITTALS

A. Submittal data shall be organized in commercial quality, three ring binders with durable and cleanable covers. Product information for each piece of equipment shall be separated by an indexing leaf with clear tabs. The product name and symbol (i.e., AHU/Air Handling Unit) shall be typed on white paper inserts and placed in appropriate tab. Complete data must be furnished showing performance, quality, and dimensions. A signed review by the Architect/Engineer must be obtained before purchasing any equipment.

B. The following items shall be submitted for review by the Architect/Engineer but are not limited to:

1. Air Conditioning Units
2. Fans
3. Diffusers, Registers, and Grilles
4. Fire Dampers
5. Pipe Insulation
6. Duct Insulation
7. Coils
8. Temperature Controls
9. Cross Connection Control Devices
10. Plenum Materials and Supports
11. Pumps
12. Hydronic Air Control Devices
13. Filter Assemblies and Filters
14. Fan Coil Units
15. Heat Exchangers
16. Flexible Pipe Connections

17. Heating Terminal Equipment

18. Roof Top Equipment

19. Ductwork Shop Drawings

20. Radiant Heating Equipment

21. Vibration Isolation Equipment and Calculations

1.8 QUALITY ASSURANCE

A. General: Comply with Division 1.

B. Welder Qualifications: Welders shall be certified by the American Society of Mechanical Engineers (ASME) National Certified Pipe for the type of work being performed. Current operators' certificates in accordance with ASME standards shall be on file at the site and shall be available to the Architect/Engineer for examination. Coupons shall be available for review by the Architect and Engineer.

C. Locations of all pipes, ducts, outlets, appliance, etc., as shown on the drawings, are approximate only and are understood to be subject to such revisions as may prove necessary or desirable at the time the work is installed. Each Contractor will be required to install his work with relation to existing building conditions and shall be entirely responsible for the correctness of his work with reference to finished elevations, etc. Piping shown on the drawings is diagrammatic only and their exact locations, depths, and invert elevations shall be as required for proper flow and coordination with other trades.

D. The contract drawing depicts graphically the arrangement of piping and ductwork. Should local conditions necessitate a rearrangement, or if any of the piping or ductwork can be installed to better advantage in a different manner, the Contractor shall, before proceeding with the work, prepare and submit three (3) copies of Drawings of the proposed arrangement for the Architect/Engineer's review.

E. If the Contractor proposes to install equipment, including piping and ductwork, requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the Architect/Engineer review the change before proceeding with the work. The request for such change shall be accompanied by Shop Drawings of the space in question.

F. Each Contractor is responsible for the proper location and size of all slots, holes, or openings in the building structure pertaining to his work, and for the correct location of pipe sleeves.

G. Each Contractor shall coordinate his work with that of all other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipelines which require a stated grade for proper operation. Drainage lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork.

H. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Lubricate all equipment properly in accordance with manufacturer's instructions. Furnish zerk grease fittings on all greaseable bearings.

I. Equipment and Materials: The materials and equipment shall be new and shall be the standard products of the manufacturers regularly engaged in the production of Plumbing, Heating, Cooling, Ventilation, and Fire Protection Equipment, and shall be the manufacturer's latest standard design. Where two or more units of the same class of equipment are required, these units shall be the products of the same manufacturer. However, the component parts of the systems need not be the products of the same manufacturer. Specific equipment specified hereinafter is to be considered a standard of quality and operation. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the drawings. Reference shall be made to the schedules for specific information. The capacities shown are minimum capacities. Variations in the characteristics will be permitted only on written approval of the Architect/Engineer. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible all items of the same type (i.e., pumps, fans, etc.) shall be by the same manufacturer. Where installation instructions are not included in these specifications or on the plans, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is to be installed.

J. Excavation and Backfilling: This Contractor shall do all necessary excavation and backfill for the installation of the Mechanical systems as may be required. Curb cuts, asphalt, and concrete patching, cutting, and patching existing floor, etc., shall be part of this Contractor's responsibility. No extra payment will be made for rock excavation. Trenches for all underground piping shall be excavated to the required depths. The bottoms of trenches shall be tamped hard and graded to secure maximum fall. Bell holes shall be excavated to assure the pipe resting for its entire length on solid ground. Should rock be encountered, it shall be excavated to a depth of 6 inches below the bottom of the pipe, and before laying the pipe, the space between the bottom of the pipe and the rock surface shall be filled with gravel, thoroughly tamped. Pipe laid in trenches dug in fill shall be supported down in the trenches and shall be filled. No roots, rocks or foreign materials of any description shall be used in backfilling the trenches. The backfill material shall be identical to the surrounding fill material and shall be placed in 6-inch layer, wetted, and compacted to the density of the adjacent soil. See Division 2 for additional information for site utilities. All surplus materials shall be hauled from the project by the Contractor at his expense.

K. Cutting and Repairing:

1. Responsibility of the Contractor whose work is involved. Coordinate with others to prevent unnecessary cutting and repairing.

2. Lay out and locate equipment, openings, and chases. Install sleeves, inserts, and supports. Arrange with those whose work is involved to do cutting and replacing caused by negligence or error with costs reimbursed by the Contractor at fault. Cutting and replacing of existing work shall be the responsibility of the Contractor whose work is being installed.

3. Removal or terminating connections of existing work which is abandoned or replaced shall also be done hereunder to provide correct and finished work.

L. Foundations: All equipment shall be provided with suitable foundations and supports. It shall be the responsibility of the Contractor to provide for the proper locations of these foundations and supports. This applies to all rooftop equipment also.

1. All concrete foundations required by equipment furnished by the Mechanical Contractor shall be constructed by them (except where otherwise noted) the conformity with the recommendations of the manufacturer of the respective equipment, and with the approval of the Architect/Engineer. All corners of the foundations shall be neatly chamfered. Foundation bolts shall be placed in the forms when the concrete is poured. Allow 1 inch below the equipment base for alignment, leveling and grouting with non-shrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary. After removal of the forms, the surface of the foundation shall be rubbed.

2. Unless otherwise noted, foundations shall be a minimum of 6-inch high. All concrete work performed by these Contractors shall conform entirely to the requirements of the Concrete Specifications which describe this class of work.

M. Code Requirements: Comply with state and local code requirements and ordinances. Call for inspections required by responsible building inspection authority.

N. Applicable Building Codes and Ordinances: Including the latest edition of each code, but not limited to the following:

1. International Building Code.

2. Uniform Mechanical Code.

3. Uniform Plumbing Code.

4. Governing Fire Department Requirements

5. Utility Company Requirements

6. National Fire Protection Association Standards

7. NFPA 70 - National Electrical Code

8. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

9. NEPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

10. NFPA 13 - Sprinkler Systems

11. NFPA 101 - Life Safety

12. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Laden Vapors from Commercial Cooking Equipment

13. International Energy Conservation Code 2018

O. Access Panels

1. Similar to Milcor, or as noted on the drawings, size as required for concealed expansion joints, valving, gauges, balancing dampers, valves, traps, pitot stations, equipment and similar items requiring accessibility. Notify the General Contractor of each access panel location and the required size. Panels shall be proper type for ceiling or wall in which they are installed. The panels shall be furnished under this section of the Specifications, unless otherwise directed, but shall be coordinated to be compatible with walls and ceilings furnished under other sections.

1.9 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1

B. Large Items: Make arrangements with other trades on the job for introduction into the building of equipment too large to pass through finished openings.

C. Acceptance: Check and sign for materials to be furnished by others for installation under all Mechanical Divisions upon delivery. Contractor shall be responsible for the storage and safekeeping of such materials from time of delivery until final acceptance.

D. Protection: Close ends of pipe and ductwork at the close of each working day during construction to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Protect fixtures and equipment against damage during mechanical work with heavy paper or plastic until final clean-up.

E. Storage: Store equipment in covered enclosure or wrap with weather tight 6 mil Visqeen.

F. Shipping Protection: Protective casings, crating, and coverings to remain in place until start-up of equipment.

1.10 PROJECT CONDITIONS

A. Performance: All systems are to be rated at 3,575 ft. elevation.

1.11 SEQUENCING AND SCHEDULING

A. General: Comply with Division 1.

B. Schedule: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

C. Utility Interruptions: Schedule mechanical utility interruptions with the Architect/Engineer/Owner minimum of seven (7) days prior to the requested outage. Plan work so that duration of the interruptions a maximum of one day.

1.12 CONTROLS WIRING AND ELECTRICAL EQUIPMENT

A. All mechanical equipment controls wiring, conduit, relays, interlocks, and all accessories required for a completely operational controls system shall be the complete responsibility of the mechanical contractor. The mechanical contractor has the option to hire the project electrical contractor or any qualified controls contractor to install mechanical controls wiring and conduit. Refer to specification 251000 for installation requirements. Refer to Specification Section 253000 for coordination requirements between mechanical, electrical, and controls subcontractors.

B. Electrical items such as disconnect switches and motor starters associated with equipment provided by Division 23, when specifically mentioned to be furnished by the Mechanical Contractor, whether in these specifications or on the Electrical or Mechanical Drawings, shall be furnished by the Contractor. These items shall be mounted and connected as required for a completely operational system. See Control Systems Specification for further information.

C. All electrical equipment characteristics (voltage, etc.) must be verified by the Contractor prior to ordering. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Architect/Engineer of the change and shall then coordinate the change with the Electrical Contractor and shall pay all additional charges in connection with the change.

D. All motors shall meet all the requirements of all Electrical Divisions.

1. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general-purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. All motors shall have copper windings. All motors to have minimum power factor of 85% or have switched correction to 90%. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40°C rise and total temperature rise of 65°C ambient and when powered from the system voltage feeding the motor. TEFC motors shall a service factor of 1.00 with total temperature is of 65°C in the above conditions. Motors located in areas exceeding 40°C ambient shall be factory-rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors. Single phase motors of 1/10 HP or less may be shaded pole induction motors.

1.13 PROTECTION AGAINST HAZARDOUS CONDITIONS

A. The Contractor shall take precautions against hazardous construction conditions at all times during construction. The final condition of the facilities shall be safe, and where safety to operating personnel is jeopardized, suitable signage shall be posted.

B. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operating personnel, shall be cut back and/or protected to reduce the risk of injury. All openings between floors shall be protected with barriers around the openings, gratings across the openings, or steel bars through the openings to avoid and protect against injury.

1.14 HAZARDOUS SIGNS

A. Equipment room contains moving or rotating parts, floor openings, or other potentially hazardous environments and shall include a sign on the door entering it that shall read similar to the following: **Hazardous Area - Authorized Personnel Only.**

1.15 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Mechanical Contractor shall furnish to the Owner a bound (three (3) ring binder) manual in triplicate, containing complete repair parts lists, and operating, service, and maintenance instructions on all mechanical equipment, fixtures, and systems, as noted below:

1. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect/Engineer, Sub-consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

2. For Each Product System: List names, addresses and telephone numbers of Sub-contractors and suppliers, including local source of supplies and replacement parts.

3. Product Data: Mark each sheet to clearly identify specific product and component parts, and data applicable to installation. Delete inapplicable information.

4. Warranties and Bonds: Bind in copy of each.

5. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

6. Include color-coded wiring diagrams as installed for control system.

7. Operating Procedures: Include start-up, break-in and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.

8. Maintenance Requirements: Include routine procedures and guide for troubleshooting, disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

9. Provide servicing and lubrication schedule and list of lubricants required.

10. Include manufacturer’s printed operation and maintenance instructions.

11. Include sequence of operation by controls manufacturer.

12. Provide original manufacturer’s part list, illustrations, assembly drawings and diagrams required for maintenance.

13. Provide control diagrams by controls manufacturer as installed.

14. Provide charts of valve tag numbers, with locations and functions of each valve, keyed to flow and control diagrams.

15. Provide list of original manufacturer's spare parts and recommended quantities and to be maintained in storage.

16. Include Test and Balance (T&B) Reports as specified in Section 230593.

B. The Mechanical Contractor shall also provide training as required by Section 230100 to the Owner's operation and maintenance personnel.

1.16 OPERATION PRIOR TO ACCEPTANCE

A. The Owner shall have the right to operate any and all apparatus as soon as and as long as it is in operating condition, after Owner personnel have received operational training, whether or not such apparatus has been accepted as complete and satisfactory, except that this shall not be construed to mean operations before any required alterations or repairs have been made. This operation does not indicate acceptance of the equipment by the Owner. When the Contractor enters into a contract with the Owner, he agrees to the above.

1.17 WARRANTY AND SERVICE PROGRAM

A. Due to the critical performance requirements and to clearly establish warranty responsibility for this project, the Contractor shall provide a full-service maintenance and warranty program to the Owner for one full year after beneficial occupancy (substantial completion).

B. This service program shall be included as part of the base bid and shall include service, maintenance, repair, replacement, lubrication, temperature control calibration and repairs, and documenting proof for all service and maintenance work on all equipment and system furnished by the Contractor.

C. A single representative in the employment of the Contractor shall be responsible for coordination and follow through of this program. This representative's name and phone number shall be submitted to the Owner as part of the maintenance manuals and supportive data. The Contractor shall respond to a request for service with 24 hours if so requested.

D. During this first year of operation, the following sequence of maintenance service shall be performed as a minimum.

1. Clean strainers in piping.

2. Fans and/or pumps be lubricated and oiled once every four (4) months.

3. Controls shall be calibrated throughout the facility at the end of six (6) months (following substantial completion). Any leaks in the piping systems shall be repaired.

4. All equipment manufacturer's service recommendations shall be followed during this period.

1.18 FLUSHING AND DRAINING

A. It shall be the responsibility of this Contractor to properly drain and flush all ducts and pipes before use or acceptance to ensure that all debris is completely removed. Damage caused by such debris remaining in the ducts or pipes shall be repaired by this Contractor at his expense. This Contractor shall demonstrate to the Architect/Engineer's representative that all piping is clean.

1.19 CLEANING

A. This Contractor shall remove from the building construction site all rubbish and dirt as it accumulates under the contract. At completion, all areas shall be broom cleaned and all obstructions, surplus materials, etc., removed.

1.20 GUARANTEE

A. The Contractor shall guarantee all materials, equipment, and workmanship furnished and installed by him under this Contract, to be free from all defects of workmanship and materials, and shall agree to replace at his expense, without expense to the Owner, at any time within one year after installation is accepted by the Architect/Engineer, any and all defective equipment, parts, etc., that may be found. (This excludes normal maintenance and daily servicing of equipment which is the Owner's responsibility.)

1.21 FLOOR, WALL, AND CEILING PLATES

A. Where exposed pipes pass through floors, finished walls, or finished ceiling, they shall be fitted with chromium-plated escutcheons of an approved pattern. Escutcheons and plates in Mechanical Rooms do not require chrome finish.

B. This Contractor shall be responsible for providing and installing all counter flashing. All openings in the roof shall be flashed and counterflashed. Use four-pound lead flashing materials for all vent lines and welded flashing in steel lines passing through roof. The Mechanical Contractor shall notify the General Contractor where each roof penetration is and the size of the opening.

1.22 PIPE SLEEVES

A. Schedule 40 steel pipe sleeves or pipe sleeves made of No. 20 gauge galvanized steel, properly secured in place with approximately 1/4" space between each sleeve and the surface of the pipe and/or insulation passing through it, shall be provided for all pipes passing through concrete floors, roofs, and masonry walls. All pipe sleeves shall be fixed in place as the walls and floors are built up. The Contractor shall furnish and locate all sleeves and pipes passing through concrete floors, exterior masonry walls, and roofs shall be made watertight with approved non-hardening plastic material. Sleeves through pipe chase or equipment room floors shall project a minimum of 2-inch above the floor and shall be of black steel pipe with waterproof flange at center of floor thickness. Each sleeve through a fireproof wall shall be packed with approved fireproof rope in the annular space.

1.23 PIPE HANGERS

A. Pipe hangers shall be Fee and Mason of a type suitable for each use. Perforated straps shall not be used in any work. For ferrous pipes up to and including 4 inch in size, use Fee and Mason Fig.

199 malleable iron, adjustable, split ring, swivel hanger. For plumbing piping larger than 4 inches, use Fee and Mason Fig 239 steel clevis hanger. Where several pipes are parallel at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on rollers where indicated on the Drawings. For copper pipes up to and including 3 inch in size, use Fee and Mason Fig. 360 malleable iron, copper plated hangers. For copper pipes larger than 3 inches, use Fee and Mason Fig. 364 copper plated clevis hanger.

B. Hanger rod sizes shall conform to the following schedule:

1. Pipe up to and including 2"	3/8" rods
2. Pipe 2-1/2", 3" and 3-1/2"	1/2" rods
3. Pipe 4" and 5"	5/8" rods
4. Pipe 6"	3/4" rods
5. Pipe 8”, 10”, and 12”	7/8” rods

C. Unless shown otherwise on the Plans, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following spacing:

1. Pipe up to and including 1-1/4"	8'
2. Pipe 1-1/2" and 2"	10'
3. Pipe 2-1/2" and 3"	12'
4. Pipe 3 1/2” and 4”	14’
5. Pipe 5” and 6”	16’
6. Pipe 8” and 10”	20’

D. Unless shown otherwise on the Plans, all horizontal runs of copper piping shall be suspended from the floor or roof construction as the case may be, by means of hangers with the following maximum spacing:

1. Pipe up to 3/4" in size	5'
2. Pipe 1" and 1-1/4"	6'
3. Pipe 1-1/2" and larger	10'

E. There shall be a hanger within 2 inches of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps at each floor. Vertical pipes within a space shall have not less than two supports.

F. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting, nor shall it be supported from equipment connection.

G. Hanger rods for all equipment, pipes, ducts, trapezes, vibration isolators, etc., shall be installed straight, true, and plumb. Do not bend or flex hanger rods to accommodate sloping structures, avoid obstacles, or for any other purpose. Where necessary, utilize swivel beam clamps, beveled or swivel hardware, angled, swivel or hinged brackets spanning members or other appropriate means of connection.

H. Expansion bolts shall be Ackerman-Johnson or Hilti.

I. Beam clamps suitable for use with this type of steel construction involved shall be Grinnell.

1.24 PRESSURE VESSEL CERTIFICATION

A. Not used.

1.25 ISOLATION

A. Excessive vibration or objectionable noise created in any part of the building by the operation of any equipment furnished and/or installed under the Mechanical Contract will be extremely objectionable and the Contractor shall take all precautions against the same by isolating the various items of equipment from the building structure and by such other means as may be necessary to eliminate all excessive vibration and objectionable noise produced by any equipment installed by them, and consequently, they shall design all foundations, supports, etc., for their equipment, and all piping with this end in view. In addition, these Contractors shall supervise the construction of all foundations and supports, whether they build them or not, in order that they may be constructed in such a manner as to prevent the transmission of objectionable noise and/or excessive vibration. Submit calculations on all vibration isolation equipment.

B. All equipment having moving parts shall be isolated from the building structure by means of Korfund isolation materials, unless specifically noted otherwise. All isolators shall be the same brand and shall be supplied from the same source. Equipment manufacturer's recommendations shall be followed in the isolation of equipment.

C. Vibration isolators shall have sufficient resilience to meet the following minimum efficiencies:

Motor HP	Equipment Room
Up to 5	90%
7-1/2 to 15	93%
20 to 40	95%
50 to 100	97.5%

D. Spring isolators shall be of the housed type with ribbed pads bonded to the underside of the baseplate or may be unhoused stable springs. Isolators shall be furnished with snubbers and limit stops where so recommended by the equipment manufacturer.

E. The Supplier of the isolating equipment shall, upon completion of the job, check all isolating materials and verify that they are installed properly, and submit a report in writing to the Architect/Engineer.

1.26 TESTING

A. Before completion of this project, the Mechanical Contractor shall test all materials and equipment which normally require testing. All piping, etc., shall be tested to meet code requirements or the Specification requirements, whichever is more stringent.

B. All equipment shall be operated sufficiently long enough to prove to the Architect/Engineer that the equipment performs satisfactorily and meets the requirements set forth on the Plans or in these Specifications.

1.27 CERTIFICATIONS

A. Before receiving final payment, the contractor shall verify that all equipment furnished, and all work done is in compliance with all applicable codes mentioned in these Specifications. Submit certifications and acceptable certificates to the Architect/Engineer.

1.28 GENERAL PIPING INSTALLATION REQUIREMENTS

A. Provisions for Drainage: All piping systems shall be installed so that they may be easily drained. Drain caps, plugs, or hose bibbs shall be installed at low points. Grade piping toward drain locations.

B. Alignment: All installed pipelines shall be straight and shall remain straight against strains. Proper allowance shall be made for expansion and contraction.

C. Clean as Installed: All piping shall be kept free from scale or loose dirt when installed and must be kept clean during the completion of the installation. All openings in the piping system shall be capped or plugged while awaiting further connections. All detergents, solvents and other cleaning agents shall be compatible with the materials of fabrication of the system in which they are used. They shall not adversely affect the materials of mechanisms in the systems and they shall be acceptable to equipment manufacturers. All detergents, solvents, and other cleaning agents shall also be compatible with the process streams to be handled by the systems in which they are used.

D. Insulated Fittings: Install between any dissimilar metals such as steel and copper.

E. Expansion and Contraction: The Contractor shall make all necessary provisions for expansion and contraction with proper fittings, anchors, dresser couplings, loops, etc. Install flexible connectors on each pipe at each building expansion joint.

F. Welding: Refer to Paragraph 1.29 of this section of these specifications.

G. Bending: No bending of pipe will be permitted.

H. General: The installation shall be coordinated with respect to space available with heating, cooling, ventilating, and electrical installation. In every instance where there is a conflict in the routing of the piping and the ducting, the routing of the ducting shall govern. Installed piping

shall not interfere with the operation or accessibility of doors or windows, shall not encroach on aisles, passageways, and equipment, and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping, installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping above ground shall be run parallel with the lines of the building unless otherwise noted on the drawings. Unless otherwise shown on the drawings, horizontal piping shall pitch down in the direction of flow with grade of not less than 1 inch in 40 feet. Piping connections to equipment shall be in accordance with details shown on the drawings or as recommended by the equipment manufacturer. Service pipe valves and fittings shall be kept a sufficient distance from other work to permit finished covering not less than 1/2 inch from such other work, and not less than 1/2 inch between finished covering on the different services.

I. Installation of Valves: Valves shall be installed at the locations shown on the drawings and where specified and where directed at site. Gate valves shall be used unless otherwise shown, specified, or directed. All valves shall be installed with their stems horizontal or above. Where tight shutoff is required, a composition seat globe valve or resilient seat ball valve shall be used.

J. All valves which must be used during operation, all control valve assemblies, instrument control cases, liquid level controls, gage glasses, orifices, relief valves, and other equipment which must be observed, adjusted, or serviced during operation shall be located conveniently accessible from an operating platform or grade.

K. In general, relief valves within processing unit limits shall be located conveniently accessible from an operating platform or grade.

1. Those in non-hazardous service, such as water, shall discharge directly to outside.

2. Relief valves should have no piping between the vessel or line and the valve inlet, except as shown on the drawings.

3. Relief valves shall be installed in a vertical position. Vent piping shall be braced and supported in a manner that will not produce excessive stresses in the relief valve and will permit removal of the relief valve without necessary temporary supports for the vent lines.

L. Equipment Connections: All piping connections to pumps and other equipment shall be installed without strain at the pipe connection of the equipment. The contractor shall be required as directed to remove the bolts in flanged connections or disconnect piping to demonstrate that the piping has been so connected. Pipe connections to equipment shall be made with unions or flanged fittings. Provide removable headers for large equipment for service access.

M. Joints

1. Flanged Joints: All flanged joints shall be face matched. Raised face flanges shall not be mated to flat-faced cast-iron flanges on valves or equipment. The raised face must be turned off. All flanged bolt holes shall straddle the horizontal and vertical center line unless otherwise noted.

2. Screwed Joints: Screwed pipe joints shall have American Standard Taper Pipe Threads ANSI-B2.1 Latest Edition. Burrs formed when cutting pipe shall be removed by reaming. Care shall be taken that the inside of pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Joints shall be made perfectly tight by the use of Teflon tape or approved Teflon thread sealing and lubricating compound.

3. Solder-Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool or wire brush before seating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for serrated fittings on water, compressed air below 60 psig, and vacuum lines shall be made with a 95 percent tin and 5 percent antimony. Cored solder or solder containing lead will not be permitted.

N. Reducers: Reduction in pipe size shall be made with one piece reducing fittings. Bushings reducing at least two pipe sizes will be acceptable only when there is no room for reducing couplings or swaged nipples.

O. Unions: All piping unions shall be of the ground joint type constructed from materials equivalent in alloy composition and strength to other fittings specified with which they are used. Union Pressure classes and end connections shall be the same as the fittings used in the lines with the unions. Steel unions shall have hardened stainless steel seating surfaces on both faces.

P. Hanger Supports:

1. All hanger rods used to support piping, conduit, mechanical units, equipment, trapezes, and other items shall be straight and installed plumb, regardless of length. Do not bend rods to adapt to sloped or rotated structural members, secondary support members or to sloped mounting holes on supported equipment. Contractor shall utilize available swivel, hinged, or rigid mounting techniques designed to accommodate a slope or rotation, or shall design a custom solution. Selected techniques for each application shall be submitted for approval prior to use.

2. Do not bend rods to circumvent an obstruction.

3. Loads on hanger rods shall be applied in direct tension. Do not apply compression, lateral or moment loads to hanger rods. Install bracing or additional supports to prevent hanger rod from incurring non-tension loading.

4. Do not create offsets in rods; use only in-line couplers, and only when length of coupled rod exceeds standard available length (typically 12 feet), or when full lengths cannot be placed in position. Provide additional horizontal bracing to prevent swaying of supported piping or equipment.

5. Do not straighten bent rods for subsequent use. If a rod becomes bent, cut off and discard the bent portion. Remaining straight portion of rod may be used.

1.29 WELDING

A. All welding of piping covered by this specification, regardless of condition of service shall be accompanied as follows:

1. The welding shall be in accordance with the recommendations of the American Welding Society. Mitering of pipe to form elbows, notching to form these, or any similar construction will not be permitted. Welding fittings shall be installed on all welded lines. Joints to be welded shall be properly aligned and spaced, using special welding clamps where necessary. All welders to be employed shall have passed qualification tests prescribed by the National Certified Pipe Welding bureau (or by another reputable testing laboratory or agency) using procedures approved by the American Society of Mechanical Engineers or the American Welding Society. The welders will be required to pass qualification tests when the work of the welder creates a reasonable doubt as to his proficiency. Tests shall be conducted at no additional expense to the Owner.

2. Each welder shall, in addition to having passed the prescribed qualification tests (as noted in Paragraph 1.30.A.1), prepare sample coupons at the job site on a portion of pipe that is cut such that the cross section of the weld is opened to view. The sample weld should be prepared using a 6-inch diameter pipe. The sample shall reflect a continuous weld with perpendicular cut out to show the weld in cross sectional view. This sample, when accepted and approved by a certified welding inspector, shall be used as a standard of quality to compare to other welds that this welder will be performing on the job. This same sample weld will also be a basis for accepting or rejecting the welder for working on this project. The sample weld shall be identified with a date and the welder's name and shall be kept at the site throughout the project.

3. All welding on pressure piping shall conform to all of the requirements of the American Society of Mechanical Engineers Code for Pressure Piping - B31.1 (An American National Standards Institute publication), as defined in the latest edition of the ANSI Power Piping B31.1 Manual. All welding shall also conform to all of the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. All chapters, current addenda and supplements of these manuals shall apply. This code shall be used to establish standards of performance and quality of welds. However, the Owner reserves the right to perform radiographic testing of all welds, to compare any of the welds to the approved "standard" sample welds of each welder, and to compare the welds to the welding diagrams and sketches of those recommended in the ANSI B31.1 Power Piping Manual. The intent is to obtain the highest quality welding job possible. The cost of any initial radiographic testing, for random inspection, shall be paid for by the Owner. If radiographic random testing reveals that a weld is defective, the Contractor shall bear the cost of all repairs and re-testing necessary to be made to subject weld until conformance with radiographic tests is reached. The potential for random radiographic testing and welding quality control applies to all pressure piping systems in this project, including systems below 100 psig. If a question should arise regarding the possibility of faulty welding or if there are obvious visual defects in the welding, the Contractor shall be required to correct such deficiencies to a quality level consistent with the recommendations, welding diagrams and sketches in the ANSI B31.1 Manual. The quality level shall also reflect that of the approved sample welds accomplished by each welder for this particular project.

1.30 TESTING FOR PIPING SYSTEMS

A. General: Before insulation is applied, all piping, equipment, and accessories installed under this contract shall be inspected and tested by the Contractor. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure

range is below that of the test pressure shall be removed from the line or blanked off before applying tests. Prior to performing tests, all lines shall be "blown" free of all loose dirt and foreign particles. The lines shall then be thoroughly flushed with water (liquid lines only) at a sufficient flow rate and period of time, to ensure complete cleaning of the lines of all dirt, scale, and foreign matter. Satisfactory flushing of the lines shall be subject to approval. After testing and flushing lines, all filters and strainers shall be cleaned.

B. Safety: Since the Risk of failure, with the attendant possibility of injury, is appreciable greater with further testing, all safety measures required by codes or ordinance or reasonable applicable to the situation shall be taken.

C. Concealment: Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Compression joint underground piping may be backfilled prior to pressure test except that joints shall remain exposed until after the test, but tie rods, clamps, etc., shall be in place and fastened.

D. Pressure Ratings: These tests shall not be used to establish pressure ratings.

E. System Protection: Protect all piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during the filling, testing, and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating. Note that where significant differences in elevation exists, there is a risk of overpressure in the lower portions of the system in order to attain test pressure in the upper portion of the system.

F. Test Temperature: Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes require testing above a specified minimum temperature.

G. Sectionalizing: Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

H. Temporary Supports: During hydrostatic testing of lines provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

I. Testing: Domestic hot and cold water piping and heating water piping shall be tested hydrostatically at the test pressures specified and shall show no drop in pressure in a 2 hour period. Leaks shall be located by soap testing

J. Test Report

1. A detailed report of pressure tests on piping and equipment shall be forwarded in duplicate to the Architect/Engineer. This report shall show date of test, lines tested, test medium, length of time test pressure was held, pressure drop or rise, and extent of venting or repressurizing.

1.31 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other sections of these specifications covering the work of other trades which must be carried out in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination.

1.32 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions covering the mechanical work at the building. No extra compensation shall be claimed or allowed on account of difference between actual dimensions and those indicated on the drawings. He shall examine the adjoining work on which Mechanical work is dependent for maximum efficiency and shall report any work which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable work conditions affecting Mechanical work.

1.33 SAFETY GUARDS

A. The Mechanical Contractor shall furnish and install safety guards required in order to obtain certificates of inspection from all authorities having jurisdiction. All belt driven equipment, projecting shafts, and other rotating parts shall be enclosed or adequately guarded. Provide coupling guards on all rotating shafts.

1.34 PROTECTION

A. All work, equipment, and materials shall be protected at all times to prevent obstruction, damage, or breakage. All pipe openings shall be closed with caps or plugs during installation. All equipment shall be covered and protected against dirt, water, chemical, or mechanical injury. At the completion of the work, all equipment shall be thoroughly cleaned, and the entire system shall be delivered in a perfect, unblemished condition.

1.35 PAINTING AND IDENTIFICATION

A. All equipment shall be delivered to the job with suitable factory finish. Should the finish be marred in transit or during installation, it shall be finished to present a neat, workmanlike appearance.

B. Except as elsewhere hereinafter specifically required, any painting of equipment, piping, ductwork, grilles, insulation, etc., furnished and installed under this Section of the Specifications will be done by the Painting Contractor. However, the Mechanical Contractor shall leave his equipment clean and free from any grease, dirt, rust, etc., and in suitable condition for painting.

C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.

D. The piping shall be painted the basic color as indicated in other sections of these specifications and shall be marked every 10 feet on centers with Brady pipe markers. Arrows, approximately 6 inch in length and spaced about 10 feet on centers shall indicate the direction of the flow pipe. Locate additional labels as required in Mechanical Rooms. Staple in place, brush with clear lacquer. Markers shall state pipe size, flow direction, and pipe usage (such as "cold water," etc.).

1.36 RECORD DRAWINGS

A. The Contractor shall, during the execution of the work, maintain a complete set of drawings upon which all dimensional locations of equipment piping and all deviations and/or changes in the work shall be recorded. Water, storm, and drainage mains shall be delivered to the Architect/Engineer in good condition upon the completion and acceptance of the work and before final payment is made.

1.37 SUPPLIER RESPONSIBILITY

A. Each supplier, whether furnishing equipment as specified or as a substitution shall be responsible for certifying that the equipment is properly installed and that the warranty is valid. Submit written reports on the installation and the equipment performance when requested to do so by the Architect/Engineer (or his representative). Each supplier shall be responsible for furnishing qualified personnel at the job site at anytime requested by the Architect/Engineer (or his representative) during the construction or warranty periods.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. It is the intent of this specification to define all motors furnished under all sections of the specifications for this project which will provide efficient operation, reliability, ease of maintenance, and repair along with reduced operation costs.

B. All general-purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. Motors shall be rated explosion-proof when located in hazardous atmospheres.

C. Motors mounted in direct sun shall be provided with a shield to forbid direct radiation from the sun when the sun is 45 degrees or greater above the horizon.

D. All supply fan motors mounted in air handling units shall have Class F insulation.

E. Open drip-proof motors shall be NEMA design B with Class B insulation and a 1.15 service factor with 40 degrees C ambient and a total temperature rise of 65 degrees C.

F. TEFC motors shall be NEMA design B with Class F insulation and a 1.15 service factor with 40 degrees C ambient and a total temperature rise of 65 degrees C.

G. Severe duty motors shall be NEMA design B with Class F insulation and a 1.15 service factor with 40 degrees C ambient and a total temperature rise of 65 degrees C.

1.3 GENERAL

A. All motors covered by this specification shall conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC Standards. They shall be free from defective material and workmanship and fully capable of performing in accordance with the manufacturer's nameplate rating.

B. Motors shall be approved by Underwriter's Laboratories (UL) for the service specified.

C. Unless otherwise specified, motors shall be suitable for operation in either direction--(CW or CCW) or rotation.

D. Motors shall be Westinghouse II, Reliance XE, Gould E-PLUS, GE Energy Savery, or approved equal.

E. All fractional H.P. motors shall be permanent split capacitor (P.S.C.) with U.L. listed overload protection. The protector shall be calibrated to trip out when the winding reaches a pre-determined temperature and automatically reset when the temperature returns to a safe limit.

1.4 EFFICIENCY

A. All motors shall be special high efficiency design. These motors shall be different than manufacturers' standard product, in that losses are reduced by incorporation of design features including the use of low loss lamination steel, increase in stator/rotor length, increase in copper windings, utilization of high efficiency ventilating fan, computer optimized slot configuration and air gap.

B. All motors shall be all copper wound, high power factor, high efficiency motors. Motor efficiency shall be as determined by IEEE Standard 112A, test method B. Test results shall be submitted to the Engineer.

C. Manufacturer to furnish % efficiency, % PF, amps at Full Load, 3/4 Load, and 1/2 Load with quotation and be prepared to furnish actual test results on individual ratings if required.

PART 2 – PRODUCTS

2.1 GENERAL

A. Motors shall be 60 Hertz voltage as indicated on drawings, Squirrel Cage induction type suitable for across-the-line starting and continuous duty.

B. Motors shall have copper windings.

C. All motors shall be suitable for application without exceeding Class B rise in ambient temperatures up to and including 65 degrees C at 1.15 Service Factor. Motor nameplates shall state suitability for 65 degrees C ambient application.

D. All motors shall be suitable for application without exceeding Class B temperature rise at altitudes up to and including 9900 feet at a 1.00 Service Factor.

E. Motors shall operate successfully under running conditions at rated load with +10% of rated voltage or +5% of rated frequency or a combined variation in voltage and frequency of +10% (sum of absolute values).

F. Motors will have at least a nominal 85% power factor rating at full load and rated voltage. Exclusion from this requirement are motors which draw less than 1,000 watts at full load and motors with synchronous speeds less than 1800 RPM. Test verification shall be available upon request.

2.2 INSULATION

A. Motors shall have non-hygroscopic Class B or Class F insulation system as required; however, temperature rise shall not exceed Class B rise at rated load per NEMA Standards.

B. The insulation system shall be provided with sufficient treatment so that the completed insulation system will have a minimum resistance of 1.5 megohms after 168 hours of testing to a humidity chamber maintained at 100% relative humidity and 40 degrees C ambient.

2.3 TESTS

A. Each motor shall be given a routine factory test per NEMA and ASA Standards to ensure compliance with this specification.

2.4 BEARINGS

A. Bearings shall be shielded, regreasable, vacuum degassed steel ball bearings, specially selected for electric motor service and long-life expectancy (B-10 MINIMUM).

B. Bearings shall be lubricated with a premium moisture resistant grease formulated to operate over a temperature range of -20 degrees F to +300 degrees F.

C. Bearing identification by AFBMA number shall be shown on motor nameplate.

2.5 ENCLOSURES

A. Construction shall be of rugged corrosion resistant metal including a one-piece frame, brackets, conduit box and fan shroud.

B. Fans shall be bi-directional and constructed of low inertia inert material.

2.6 CONDUIT BOXES

A. Conduit boxes are to be diagonally split, rotatable in 90 degree turns, gasketed cast iron construction with threaded conduit holes.

B. Ground lug suitable for grounding motor frame shall be furnished inside of conduit box.

C. A neoprene lead seal separator gasket shall be mounted between motor frame and conduit box to prevent entry of moisture and dust into the motor.

D. Conduit box size must meet or exceed minimum as shown in NEC Standards based on motor full load current.

2.7 HARDWARE

A. Corrosion-resistant cadmium plated grease plugs shall be provided for relubrication of bearings.

B. An external shaft flinger shall be provided on the shaft to prevent entrance of moisture or dust into the bearings.

C. All motors Frame 182T and larger shall have lifting eyebolts for lifting the entire motor.

D. An easy-to-read nameplate shall be provided on each motor and shall include at least the following information:

1. Horsepower
2. RPM
3. NEMA Design
4. Phase
5. Hertz
6. Service Factor
7. Ambient Temperature
8. Frame Size
9. Duty
10. Class of Insulation
11. Locked KVA Code
12. Full Load Amps
13. Model or Catalog Number
14. Bearing Identification
15. Guaranteed Minimum Efficiency
16. Nominal Efficiency
17. Voltage

2.8 MOTOR CONSTRUCTION

A. Motors shall be dynamically balanced to limits as indicated below:

Speed (Peak-to-Peak)	Maximum Amplitude
3500 & Above	.0010
1700 to 3499	.0015
Less than 1700	.0020

2.9 FINISH

A. All external surfaces shall be prime painted with red oxide zinc chromate primer to prevent corrosion.

B. The finish coat of paint shall be a full-gloss epoxy enamel paint. External finish shall protect against moisture and have superior heat resistance to withstand the effects of sunlight and outdoor weathering without chipping or cracking.

2.10 EFFICIENCY

A. Motors furnished shall meet or exceed the efficiency listed on the following Table.

HIGH EFFICIENCY MOTORS

HP	3600 RPM EFFICIENCY		1800 RPM EFFICIENCY		1200 RPM EFFICIENCY	
	NOMINAL	MINIMUM	NOMINAL	MINIMUM	NOMINAL	MINIMUM
1	81.5	78.5	84.0	81.5	78.5	75.5
1.5	81.5	78.5	84.0	81.5	84.0	75.5
2	84.0	81.5	84.0	81.5	86.5	84.0
3	86.5	84.0	88.5	86.5	88.5	86.5
5	88.5	86.5	90.2	88.5	88.5	86.5
7.5	88.5	86.5	90.2	88.5	88.5	86.5
10	88.5	86.5	90.2	88.5	90.2	88.5
15	90.2	88.5	91.7	90.2	90.2	88.5
20	90.2	88.5	91.7	90.2	91.7	90.2
25	90.2	88.5	93.0	91.7	91.7	90.2
30	91.7	90.2	93.0	91.7	91.7	90.2
40	91.7	90.2	93.0	91.7	93.0	91.7
50	91.7	90.2	94.1	93.0	93.0	91.7
60	93.0	91.7	94.1	93.0	93.0	91.7
75	94.1	93.0	94.1	93.0	94.1	93.0
100	94.1	93.0	95.0	94.1	94.1	93.0
150	94.1	93.0	95.0	94.1	94.1	93.0
200	94.1	93.0	95.0	94.1	95.0	94.1
250	95.0	94.1	95.0	94.5	-	-

END OF SECTION 23 05 13

SECTION 23 05 48 - VIBRATION ISOLATION AND EXPANSION COMPENSATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Vibration Isolation: All vibration isolation equipment including flexible pipe and duct connections hangers and bases shall be under the direct supervision of the vibration isolation manufacturer's representative. This specification provides the necessary design criteria to avoid excessive noise or vibration due to the operation of machinery, connecting piping, ductwork, or conduit.

1.3 RELATED WORK IN OTHER SECTIONS

220523	VALVES
220700	PIPING INSULATION
230000	HEATING, VENTILATING, AND AIR CONDITIONING INDEX
230500	GENERAL HEATING, VENTILATING, AND AIR CONDITIOING REQUIREMENTS
230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230519	PIPING SPECIALTIES

1.4 CONTRACTOR RESPONSIBILITY

A. The Contractor shall provide a submittal to the Architect/Engineer for approval prior to any installation of his equipment containing the following information:

1. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with this specification and the recommendation of the isolator manufacturer as to suitability for the specific service.

2. An itemized list showing the items of equipment, piping, and ductwork to be isolated, the isolator type and model number selected, isolator loading and deflection, and reference to specific drawings showing equipment frame construction where applicable.

3. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, support point locations, etc.

4. Written approval of the frame design to be used, obtained from the equipment manufacturer.

5. Drawings showing methods of suspension, support, guides, etc., for piping and ductwork.

6. Drawings showing methods for isolation of piping and ductwork piercing walls, slabs, beams, etc.

7. The Contractor shall bring to the Architect/Engineer's attention prior to installation any conflict with other trades which will result in unavoidable contact to the equipment, piping, etc., described herein, due to inadequate space. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

8. The Contractor shall bring to the Architect/Engineer's attention any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the expense of the Contractor.

9. The Contractor shall obtain inspection and approval from the Architect/Engineer of any installation to be covered or enclosed prior to such closure.

10. The Contractor shall obtain written and/or oral instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices; alternatively, the equipment may be installed by the vibration isolation manufacturer.

11. The Contractor shall correct, at no additional cost, all installations which are deemed defective in workmanship or materials by the contracting officer.

PART 2 – PRODUCTS

2.1 MANUFACTURERS: Vibration isolation equipment shall be as manufactured by Flexonics, Kinetics, Mason Industries, Vibration Eliminator, Co., or approved equal.

2.2 ISOLATOR TYPES

A. Spring Type

1. All spring isolators shall have either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

2. All spring isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range 50% above the design deflection.

3. The ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 1.6.

4. The vertical natural frequency for each support point, based upon the load per isolator, and isolator stiffness, shall not differ by more than plus or minus 10%.

5. Type MS shall be bare spring type (without housings or snubbers) equipped with leveling bolts and with two layers of ribbed or waffled neoprene pad separated by a 1/16 " galvanized steel plate under the base plate.

6. Type HS shall be suspension hanger having a steel frame and spring element in series with a neoprene pad or washer. The isolator shall be designed so hanger rod may be misaligned 15 relative to the vertical without touching hanger box frame.

B. Neoprene Pad Type

1. Type MN shall be a neoprene isolator unit having a minimum static deflection of 1/4" and show hardness of 40 to 65 after minimum aging.

C. Flexible pipe connectors shall consist of a minimum 12-inch length of metal reinforced or corrugated flexible metal hose of appropriate pressure and temperature rating with end connections suitably for the adjacent piping system. Connectors shall be Flexonics type MMT FLG or Vibrasorber or approved equal.

D. Flexible duct connectors shall be neoprene coated glass fabric, ventglass or equal. See Section 233000 AIR DISTRIBUTION.

2.3 EQUIPMENT FRAMES AND BASES

A. GENERAL:

1. Equipment frames and base shall be furnished and installed where specifically shown on the drawings and at other locations recommended by the isolator manufacturer. In general, rigid steel frames will be required for base mounted pumps, 30 HP and smaller, air handling units, some fans 30 HP and smaller, water chillers, cooling towers. Concrete inertia bases shall be furnished and installed for base mounted pumps 40 HP and larger and fans 40 HP and larger.

B. RIGID STEEL FRAMES

1. Mounting frame and/or brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.

2. The mounting frames shall consist of welded wide flange of channel structural steel with welded brackets to accept the isolators. The section depth of the frame member shall be greater than 1/10 the length of the longest frame member.

PART 3 – EXECUTION

3.1 GENERAL

A. Location: Vibration isolation equipment shall be installed at the following locations and at other locations recommended by the isolator manufacturer or required to reduce transmitted vibrations to a level acceptable to the Architect/Engineer and Owner.

1. All reciprocating or rotating equipment such as fans, AHU's, forced draft boilers, chiller, cooling towers, furnaces, pumps, and compressors except as follows:

    a) Equipment installed on slab on grade construction.

    b) AHU's having factory installed internal spring isolation at fans.

    c) Inline pumps having motors 1/2 HP or smaller.

2. At all connections between rotating equipment and piping or ductwork.

3. All piping and ductwork within mechanical equipment rooms or within 10 feet of connections to rotating or reciprocating equipment.

B. The Contractor shall install equipment and piping avoiding rigid contact with the building structure.

C. The Contractor shall coordinate his work with other trades to assure rigid contact between the building structure and mechanical equipment and piping is minimized.

3.2 INSTALLATION

A. Large Equipment

1. Objective: Installation of vibration isolators shall not result in any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. Equipment shall be shimmed into final, loaded position prior to making piping connections. Equipment load shall not be transferred to the isolator until the installation is complete and the equipment is under full operational load. This is particularly important where equipment installation weight is substantially different from operating weight such as cooling towers, chillers, boilers, air washers and evaporative coolers which operate with substantial water content.

2. The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.

3. Brackets shall be provided to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket shall be specified by the isolator manufacturer.

4. The operating clearance at steel frames between the bracket and the pad or floor shall be 3/8 inch, plus or minus 1/16 inch. The minimum operating clearance between the frame and the housekeeping pad or floor shall be one inch.

5. The frame shall be placed in position and the brackets supported temporarily by 3/8-inch shims prior to the installation of the machine or isolators.

6. The isolators shall be installed without raising the machine and frame .

7. After the entire system installation is completed and under full operational load, the isolator shall be adjusted so that the load is transferred from the shims to the isolator. When all isolators are properly adjusted the shims will be barely free and shall be removed. Thereafter, the shims will be used as a gauge to check that the 3/8-inch clearance is maintained so that the system will remain free of stress.

B. Pipe and Duct Hangers

1. General: Vertical rise and horizontally supported piping connected to reciprocating or rotating equipment are included herein. Domestic water and fire standpipe systems are excluded from this section of the specifications.

2. Pipe and duct hangers shall be suspended from spring isolators within mechanical equipment rooms and within 10 feet of connections to rotating or reciprocating equipment.

3. The isolators shall be installed with the isolator hanger box as close as possible to the structure.

4. The isolators shall be suspended from substantial structural members, not from slab diaphragms unless specifically approved.

5. Hanger rods shall be aligned to clear the hanger box.

6. Horizontal suspended pipe 2" and smaller shall be suspended by HS isolator type with a minimum 1.0-inch static deflection. Pipes larger than 2" shall be the same except with a minimum of 1-1/2" static deflection.

7. Horizontal pipe floor supported at slab shall be supported via Type MS with a minimum static deflection of 1.0 inch.

8. Vertical riser pipe supports shall utilize Type MS mounts selected for a minimum static deflection of 1.5 inches.

9. Vertical riser guides, if required, shall utilize Type MN mounts to avoid direct contact of piping with building.

10. Pipe sway braces where required shall utilize two neoprene elements (Type MN) to accommodate tension and compression forces.

11. Hanger rods for all equipment, pipes, ducts, trapezes, vibration isolators, etc., shall be installed straight, true and plumb. Do not bend or flex hanger rods to accommodate sloping structures, avoid obstacles, or for any other purpose. Where necessary, utilize swivel beam clamps, beveled or swivel hardware, angled, swivel or hinged brackets spanning members or other appropriate means of connection.

C. Pipe Clamps:

1. All piping whether or not spring isolated hangers are used, shall be supported with a resilient wrapping or clamp system employing a resilient element of wool felt, neoprene or other suitable material.

D. Flexible pipe connectors shall be installed between each piece of rotating or reciprocating piece of equipment and the distribution piping system.

E. Flexible duct connectors shall be installed between each unit containing a fan and the distribution ductwork. Allow at least 1" slack in fabric connectors. Fabric may be attached to ductwork by folding into the sheet metal or attaching with metal flanges.

F. Flexible duct connectors for kitchen hood exhaust systems shall be slip joint type with high temperature resilient packing material.

END OF SECTION 23 05 48

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

TAB Specification 23-0593

TEST, ADJUST, AND BALANCE GUIDE SPECIFICATION

SECTION 23 0593
TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 REQUIREMENTS

A. Testing and balancing of the mechanical systems and associated controls shall be under the direction and coordination of the owner. Test and Balance (TAB) Services shall be responsible for coordination, supervision, execution, furnishing the data required by the test procedures, and report preparation for the testing, adjusting, and balancing requirements outlined in this Section.

B. TAB will be provided by the Owner's TAB Services Contractor and paid for by the Owner. This Section serves to clarify the responsibilities of the Contractors, and the Owner's TAB Services Contractor.

C. During the testing, adjusting, and balancing work, the Owner's TAB Services Contractor may identify issues or recommended corrective measures. These will be compiled in the Installation Issues Log maintained by the PAC and RFIs will be created by the PAC as appropriate. The Construction Stage Deficiency Log will be promulgated to responsible parties via the Owner's Representative and the Architect. ***IMPLEMENTATION OF CORRECTIONS SHALL BE PERFORMED BY THE CONTRACTOR AT NO ADDITIONAL CHARGE***. If the Contractor believes recommended corrections are beyond the scope of work specified in the contract, it shall be the Contractor's responsibility to request and receive written change order authorization through the Owner's established process prior to undertaking those recommended corrections.

D. The General Contractor shall provide services of a qualified manufacturer's representative of the Direct Digital Control or Building Automation Systems and qualified representatives of the mechanical and electrical subcontractors as required for the TAB work and ***THE SUB-CONTRACTORS SHALL INCLUDE COST FOR THE CONTRACTOR'S TESTING, ADJUSTING, AND BALANCING REQUIREMENTS IN HIS CONTRACT PRICE. SERVICES OF THE TAB AGENCY SHALL BE PROVIDED BY THE OWNER AND ARE NOT PART OF THE CONTRACT PRICE***.

E. Mechanical system installation, start-up, initial testing, the preparation of Operation and Maintenance Manuals, and operator training are the responsibility of the General Contractor. The testing, adjusting, and balancing requirements in this Section do not relieve the General Contractor from the obligations to complete all portions of the work in a satisfactory and fully operational manner.

F. The Owner's TAB Services Contractor shall include the following in its Scope of Work:
1. Perform Testing and Balancing of the HVAC and Control Systems. Testing to follow successful completion of the PAC's Pre-Functional and Start-Up Checklists.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The general provisions of the Contract, including General Conditions, Supplementary General Conditions (if any), and General Requirements apply to the work specified in this Section.

B. 230500 - General Mechanical Requirements

1.03 REFERENCES

A. AABC – National Standards for Total System Balance

B. ASHRAE 111 – Practices for Measurement, Testing, Adjusting, and Balancing of Environmental Systems

C. NEBB – Procedural Standards for Measurement, Testing, Adjusting, and Balancing of Environmental Systems

D. SMACNA – HVAC Systems Testing, Adjusting, and Balancing

1.04 SUBMITTALS BY OWNER'S TAB SERVICES CONTRACTOR

A. Field Reports indicating deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

B. Report forms or outlines indicating adjusting, balancing, and equipment data required. Submit prior to commencing work.

C. Test Reports including data on forms containing information indicated in Schedules.

D. Draft copies of TAB Report for review prior to Substantial Completion of Project.

E. Copies of final TAB Report.

F. Provide submittals and reports to PAC for transmittal to Owner's Representative and Architect/Engineer.

G. Provide two (2) reports in letter size, 3-ring binders with index page, indexing tabs, and with cover identification at front and side. One (1) Electronic Copy in PDF Format. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat/temperature sensor locations.

1.05 QUALITY ASSURANCE

A. Perform total system balance in accordance with NEBB Procedural Standards.

1.06 SEQUENCING

A. Sequence TAB work in conjunction with work by the Contractor. TAB work and milestones shall be incorporated in the General Contractor's Construction Schedule.

B. Sequence TAB work to commence after completion of systems. TAB work shall be completed as a prerequisite for Substantial Completion of the Project.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 AGENCIES

A. The General Contractor will be responsible for coordination, supervision, execution, and report preparation for the testing, adjusting, and balancing requirements of this Section in coordination with the Owner's Independent Performance Assurance Contractor.

3.02 SYSTEM READINESS

A. The General Contractor shall verify that systems are installed, complete and operable before the commencement of TAB work. The General Contractor and the Owner's Independent Performance Assurance Contractor, shall insure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Direct Digital Control System and temperature controls are installed complete and operable including verification of proper end device operation and installation of required software and programming.
3. Proper thermal overload protection is in place for electrical equipment
4. Final filters are new and in place.
5. Coil fins are clean and combed if needed
6. Duct systems are clean of debris.
7. Fans are rotating correctly
8. Motors and bearings are properly lubricated.
9. Any excessive vibration has been corrected.
10. Fire/Smoke and volume dampers are in place, open, and operating properly.
11. All ductwork connections are complete, access doors are closed, and duct end caps are in place.
12. Air outlets are installed and connected.
13. Duct system leakage is minimized per the Specifications.
14. Water systems have been flushed, refilled, and vented.
15. Strainers or filters are in place and clean.
16. Control valves, check valves, and flow meters are installed and operating properly.
17. All manual valves, balancing devices, and control valves are open.
18. Pump rotation is correct and water is flowing.
19. System make-up water pressure is properly adjusted.

NMPSFA Approved Pre-Functional Checklist forms to verify the readiness of systems for TAB work are provided following the end of this Section. The General Contractor shall have personnel with direct knowledge complete the individual checklists to verify that systems are installed, complete and operable prior to the commencement of TAB work. ***These checklists do not replace any manufacturer-recommended procedures***.

B. Prior to commencement of TAB work, the General Contractor shall submit a written request to the Owner, including completed Pre-Functional Checklists forms for mechanical inspection of the project. This inspection shall be conducted by a duly appointed representative of the Mechanical Engineer's office, the Mechanical Contractor's Superintendent, and the Owner's PAC Services Contractor. The inspection shall establish to the satisfaction of all parties that the systems are ready for testing and balancing.

C. Prior to commitment of TAB work, the General Contractor and PAC Contractor shall submit completed documentation of successful Manufacturer's Start-Up of equipment and systems associated with TAB Services.

D. If the Owner's PAC and TAB Services Contractor finds that systems are not ready for TAB, the General Contractor will be subject to charges for the Owner's TAB Services Contractor's lost time and expenses.

3.03 PREPARATION

A. The Owner's TAB Services Contractor shall provide necessary calibrated instruments required for testing, adjusting, and balancing operations. The Owner's TAB Services Contractor shall make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Additional balancing devices, if required, shall be furnished and installed by Mechanical and Controls Contractors

3.04 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design conditions for supply systems and within plus or minus 10 percent of design conditions for return and exhaust systems.

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

C. If tested air quantities are not within the required limits, the Contractor must replace fan pulleys, sheaves, belts, or add balancing dampers, etc. as required to meet the Specifications. If acceptable to Contractor, TAB Agency may install replacement pulleys, sheaves, or belts as required to meet the Specifications. Installation of pulleys, sheaves, or belts by TAB Agency shall have no effect on Contractor's warranty.

D. Water: Adjust to within plus or minus 10 percent of design conditions.

3.05 ADJUSTING BY OWNER'S TAB SERVICES CONTRACTOR

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

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

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

D. Leave systems in proper working order, replace belt guards, close access doors, close doors to electrical switch boxes, restore thermostats to specified settings, and restore Direct Digital Control System to normal operation.

E. At Final Inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.06 PROCEDURE BY OWNER'S TAB SERVICES CONTRACTOR

A. Air Handling and Distribution Systems

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

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

3. The total air volume handled by the system shall be determined by means of a Pitot tube and draft gauge. The total air delivered by each duct shall be measured by Pitot tube traverses.

4. The average velocity in the duct shall be determined by velocity readings which are taken in the center of equally divided areas in the cross section of the duct. The number of areas in which velocity readings are to be taken is determined by the size of the duct, based on a maximum size of equally divided areas of 8 inches.

5. Measure air quantities at air inlets and outlets. The volume dampers, pressure controllers, outlets and other devices shall be adjusted so the air volumes will be as shown on the drawings.

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

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

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

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

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

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

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

13. Where modulating dampers are provided, take measurements and balance at extreme conditions.

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

15. On completion of the test the Owner's TAB Services Contractor shall prepare a typewritten report showing the tested values for inclusion in the Final HVAC and Controls Performance Assurance Report. This report shall include all flows, temperatures, temperature drops, and motors for the plumbing and mechanical systems. The CFM of each supply outlet with corresponding room number shall be included. This report shall include the fan RPM, nameplate data, the voltage and amperage readings of the fan motors, and the fan suction and discharge static pressure.

B. Water Systems

1. Verify systems have been flushed clean, strainers and filters are in place and clean, and that the system has been refilled and vented.

2. Verify that Contractor has installed all temperature and pressure test plugs as required to obtain a thorough flow test.

3. Balance all water flows using pump curve data. Balance all chilled water coils, hot water coils, heat exchangers, cooling towers, boilers, and chillers to specified flow rates.

4. Provide air and water entering and leaving conditions on all equipment.

5. Record pump flow rates, pressures, running amperage, and full load amperage at design flow and shut off conditions.

3.07 SCHEDULES BY OWNER'S TAB SERVICES CONTRACTOR

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Air Handling Units (RTU's, etc.)
2. Fans
3. Air Filters
4. Air Inlets and Outlets
5. Domestic Hot Water Recirculation Pumps and Water Flows

6. Direct Digital Control System
7. Building Automation System

B. The Owner's TAB Services Contractor's report shall contain all test, adjustment, and balance data and information on any discrepancies from the specifications or design conditions. The following should be included as a minimum:

1. Title Page
   a. Name of Owner's TAB Services Contractor
   b. Address of Owner's TAB Services Contractor
   c. Telephone Number(s) of Owner's TAB Services Contractor
   d. Project Name
   e. Project Location
   f. Project Architect
   g. Project Engineer
   h. Project Contractor
   i. Project Altitude
   j. Report Data

2. Summary Comments
   a. Final Performance versus Design
   b. Notable characteristics of systems
   c. Identify any instances where the actual control sequence of operation varies from the designed and submitted sequences.
   d. Summary of outdoor and exhaust air flows to indicate amount of building pressurization
   e. Nomenclature used throughout report
   f. Test conditions

3. Instrument List
   a. Instrument Used
   b. Manufacturer
   c. Model Number
   d. Serial Number
   e. Calibration Date

4. Electric Motors
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP
   d. Phase, voltage, amperage, nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave make, size, bore (as installed and any replacement)

5. V-Belt Drive
   a. Identification/Location
   b. Required driven RPM
   c. Driven sheave diameter and RPM (as installed and any replacement)
   d. Belt size and quantity
   e. Motor sheave diameter and RPM (as installed and any replacement)

6. Air Moving Equipment
   a. Location
   b. Manufacturer
   c. Model Number
   d. Serial Number
   e. Supply air flow - specified and actual
   f. Return air flow - specified and actual
   g. Outside air flow - specified and actual
   h. Total external static pressure – specified and actual
   i. Inlet pressure
   j. Discharge pressure
   k. Sheave - make/size/bore (as installed and any replacement)
   l. Belts - make/size/quantity
   m. Fan RPM

7. 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

8. Exhaust Fan Data
   a. Location
   b. Manufacturer
   c. Model Number
   d. Serial Number
   e. Air flow - specified and actual
   f. Total external static pressure – specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave - make/size/bore (as installed and any replacement)
   j. Belts - make/size/quantity
   k. Fan RPM

9. 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

10. Water Systems
    a. Location
    b. Pump Manufacturer
    c. Pump Model Number
    d. Pump Serial Number
    e. Water flow - specified and actual
    f. Total pressure – specified and actual
    g. Suction pressure
    h. Discharge pressure
    i. Full load amperage at design flow and shut off conditions

11. Vibration Test (by Owner's TAB Services Contractor if required by Owner)
    a. Location of points
        ii. Fan/pump bearing drive end
        iii. Fan/pump bearing opposite end
        iv. Motor bearing drive end
        v. Motor bearing center (if applicable)
        vi. Motor bearing opposite end
        vii. Casing bottom or top
        viii. Casing side
        ix. Duct after flexible connection (discharge)
        x. Duct after flexible connection (suction)

    b. Test readings
        i. Horizontal - velocity and displacement
        ii. Vertical - velocity and displacement
        iii. Axial - velocity and displacement

    c. Normally acceptable readings, velocity and acceleration
    d. Unusual conditions at time of test
    e. Vibration source if non-complying

12. Life Safety Systems

    a. The Contractor shall be required to demonstrate satisfactory operation of Life Safety Controls and Smoke Damper operation to the Test and Balance Agency unless the appropriate Authority Having Jurisdiction requires separate verification by the local Fire Marshal.

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New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Pre-Functional Checklist

Packaged Gas-Fired Heat/Cool HVAC Units

(Provide an individual checklist per RTU)

Project:		
Location:	System/Equipment:	
Manufacturer:	Model:	Serial:
Area/System Served:		

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. ***This checklist does not replace any manufacturer recommended procedures.*** Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish that the systems are ready for testing and balancing.

Pre-start Checks **Check box for completion**	✓	**N/A**	**Comment**
Mounting, isolators, etc. installed properly			
Gas piping, burner, and gas train installed & tested			
Gas pressure at burner is as specified			
Exhaust Venting and combustion air installed properly			
Plenums & ductwork connected and sealed			
Fire dampers installed, tested, and under control			
Fan/motor alignment performed; belts properly adjusted; bearings lubricated			
Chilled Water piping & valves installed and tested			
Electrical connections completed			
Electrical Verified: Source Panel, Panel Location, Circuit (List in Comments below)			
Disconnect switch installed properly			
Integral operating & safety controls complete & operational			
Starter is installed with proper heaters			
Temperature sensors properly located			
Building controls/DDC system operational			
Filters are installed and are clean			
Uninterrupted electrical power is available from a permanent source			
Gas Detection installed and functional (VESDA)			
Ready to start and operate under control			

Startup/Operational Checks **Check box for completion**	✓	**N/A**	**Comment**
Startup by qualified personnel (Gas Cert., Refrigeration Cert.)			
Mechanical, Electrical, and Controls Contractors present			
Fan rotation is correct (bump)			
Firing sequences, safety controls & flame safeguards verified			

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Pre-Functional Checklist

Packaged Gas-Fired Heat/Cool HVAC Units

Cooling/Heating operation and temperature controls verified			
Proper control operation verified including auto shutdown			
Startup/Operational Checks (Continued) Check box for completion	✓	**N/A**	**Comment**
Operation of Electrical & Controls interlocks verified			
Freeze protection is operational			
Combustion efficiency tests performed			
Local air leakage is acceptable			
Compressor Motor Amps: Rated_____ Actual _____ Voltage: Rated_____ Actual _____			
Supply Fan Motor Amps: Rated_____ Actual _____ Voltage: Rated_____ Actual _____			
Vibration/noise level is acceptable			
Equipment has run continuously for a minimum of (4) hours			
Preliminary O&M Manuals provided to Owner			

COMMENTS:

The above checklist items have been verified complete:

ALL FIELDS MUST BE ENTERED. NO BLANKS. IF NOT INVOLVED, N/A.

RESPONSIBLE PARTY	VERIFIED BY (Name)	COMPANY	DATE
Mechanical Contractor			
Plumbing Contractor			
General Contractor			
Controls Contractor			
Electrical Contractor			
PAC Consultant			

Pre-Functional Checklist

Packaged Gas-Fired Heat/Cool HVAC Units

NMPSFA RFM			
Manufacturer Rep.			

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Pre-Functional Checklist

EXHAUST FAN EF-XXX

PROJECT: *(Project Name)*

PROJECT NUMBER: *(Project Number)*

REPORT ID: *(Report ID Number)*

EQUIPMENT DESCRIPTION: Exhaust Fan

TAG NO: *(Equipment Tag #)*

LOCATION: *(Roof)*

AREA SERVED: *(General or Specific Area)*

This Pre-Functional Checklist is used during the Performance Assurance Process to insure the correct equipment is delivered, installed and properly started in preparation for Functional Testing of related building systems. This checklist does not take the place of the Manufacturer's recommended checkout and startup procedures.

This Checklist is divided into 4 Sections and is to be completed by the Contractor in 4 separate steps. When completing each Section, be sure to check and initial EACH line item as being completed. Each Section's items must ALL be checked complete and initialed before the form is submitted to the PAC. Any item which does not apply can be marked as "N/A" in the initial section. If this form is not used for documenting, one of similar rigor shall be used.

This filled-out checklist has been reviewed with the exceptions noted below.

COMMENTS:

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Pre-Functional Checklist

EXHAUST FAN EF-XXX

SECTION 1 – EQUIPMENT DELIVERY:

The Contractor shall complete Section 1 of this form when the equipment is delivered to the site. The purpose is to record the actual design parameters listed below along with the checklist items as indicated. Should there be any discrepancy between the Actual and the Submitted information, or any item be checked incomplete, the Contractor shall immediately notify the PAC and RFM.

DESIGN PARAMETERS:

Parameter	Designed	Submitted	Actual
Make	*(Make)*		
Model	*(Model Number)*		
Serial	*(Serial Number)*		
Fan Air Flow	*(0000)* cfm		
ESP	*(00.0)* in. wg		
Motor Size	*(00)* HP		
RPM	*(0000)* RPM		
Voltage	*(000)* V / *(0)*Φ / *(00)* Hz		

CHECKLIST ITEMS:

Initial	Complete	Description
_____	Yes / No	All related submittals approved by A/E
_____	Yes / No	O&M data provided to PAC agent
_____	Yes / No	Equipment thoroughly inspected for physical damage
_____	Yes / No	The air openings are sealed with durable plastic
_____	Yes / No	Power supply voltage and phase correct
_____	Yes / No	Electrical Verified: Source Panel, Panel Location, Circuit (List in Comments below)

COMMENTS:

The checklist items of SECTION 1 are all successfully completed……___YES ___NO

Pre-Functional Checklist
EXHAUST FAN EF-XXX

SECTION 2 – EQUIPMENT INSTALLATION:

The Contractor shall complete Section 2 of this form when the installation of the equipment is being performed. The purpose of this Section is to insure the equipment is installed to the Project Design and the Manufacturer's recommendations. Immediately notify the PAC and RFM should any item be checked incomplete.

CHECKLIST ITEMS:

Initial	Complete	Description
		General Installation Check
	Yes / No	Permanent labels affixed
	Yes / No	Casing condition good: no dents, leaks, door gaskets installed
	Yes / No	Mountings checked and shipping bolts removed
	Yes / No	Vibration isolators installed
	Yes / No	Equipment guards installed
	Yes / No	Pulleys aligned
	Yes / No	Belt tension correct
	Yes / No	Plenums clear of debris
	Yes / No	Fans rotate freely
	Yes / No	Backdraft dampers installed, per drawings, and operate freely
	Yes / No	Duct system complete
	Yes / No	Fan and motor alignment correct
	Yes / No	Fan protective shrouds for belts in place and secure
	Yes / No	Fan area clean
	Yes / No	Fan and motor properly lubricated
	Yes / No	All dampers close tightly
	Yes / No	Speed controller installed to achieve schedule CFM and E.S.P.
		Electrical Check
	Yes / No	Permanent power verified
	Yes / No	Power disconnects in place and labeled
	Yes / No	All electric connections tight
	Yes / No	Proper grounding installed for components and unit
		Controls Check
	Yes / No	All control devices and wiring complete
	Yes / No	Control system interlocks connected and functional

Pre-Functional Checklist

EXHAUST FAN EF-XXX

Initial	Complete	Description
_____	Yes / No	Communication with central system functioning

COMMENTS:

The checklist items of SECTION 2 are all successfully completed……..___YES ___NO

SECTION 3 – EQUIPMENT START-UP:

The Contractor shall complete Section 3 of this form during the Start-up procedures for the equipment. The purpose of this Section is to document that proper start-up and check-out procedures were completed and documented.

CHECKLIST ITEMS:

Initial	Complete	Description
_____	Yes / No	PAC and RFM have been notified of start-up
_____	Yes / No	Startup report completed **(attach report)**

COMMENTS:

The checklist items of SECTION 3 are all successfully completed……..___YES ___NO

Pre-Functional Checklist
EXHAUST FAN EF-XXX

SECTION 4 – NOTIFICATION FOR TESTING:

This piece of equipment is properly installed, has been properly started up and is operational and ready for performance testing.

ALL FIELDS MUST BE ENTERED. NO BLANKS. IF NOT INVOLVED, N/A.

RESPONSIBLE PARTY	VERIFIED BY (Name)	COMPANY	DATE
Mechanical Contractor			
Plumbing Contractor			
General Contractor			
Controls Contractor			
Electrical Contractor			
PAC Consultant			
NMPSFA RFM			
Manufacturer Rep.			

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Pre-Functional Checklist
Ductwork

PROJECT:

PROJECT NUMBER:

REPORT ID:

EQUIPMENT DESCRIPTION: Ductwork

TAG NO: N/A

LOCATION:

This Pre-Functional Checklist is used during the Performance Assurance Process to insure the correct equipment is delivered, installed and properly started in preparation for Functional Testing of related building systems. This checklist does not take the place of the Manufacturer's recommended checkout and startup procedures.

This Checklist is divided into 2 Sections and is to be completed by the Contractor in 2 separate steps. When completing each Section, be sure to check and initial EACH line item as being completed. Each Section's items must ALL be checked complete and initialed before the form is submitted to the PAC Authority. Any item which does not apply can be marked as "N/A" in the initial section. **If this form is not used for documenting, one approved by NMPSFA of similar rigor shall be used.**

This filled-out checklist has been reviewed with the exceptions noted below.

COMMENTS:

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

Pre-Functional Checklist
Ductwork

SECTION 1 – PRE-START CHECKS:

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish to the satisfaction of all parties that the systems are ready for testing and balancing.

Pre-start Checks Check box for completion	✓	**N/A**	**Comment**
Installation complete			
Ductwork is clean and free of debris			
Balancing dampers are installed, operable and open			
Control dampers properly installed and accessible			
Fire, smoke, and combination dampers properly installed, open and under control			
Access doors installed per specifications			
Ductwork is sealed per specifications			
Testing has been performed where required			
Duct insulation is properly installed			
Flex duct run lengths do not exceed specifications			
Registers, grilles and diffusers are installed and open			

SECTION 2 – START-UP and TESTING:

Startup/Operational Checks Check box for completion	✓	**N/A**	**Comment**
Control dampers easily stroke to full positions and span is calibrated			
Main Duct Pressure / Leak Test performed			PSI TIME
Local air leakage is acceptable			
Air noise level is acceptable			

The above checklist items have been verified complete: _____YES / _____NO

Pre-Functional Checklist
Ductwork

SECTION 2 - NOTIFICATION FOR TESTING:

This piece of equipment is properly installed, has been properly started up and is operational and ready for performance testing.

ALL FIELDS MUST BE ENTERED. NO BLANKS. IF NOT INVOLVED, N/A.

RESPONSIBLE PARTY	VERIFIED BY (Name)	COMPANY	DATE
Mechanical Contractor			
Plumbing Contractor			
Sheet Metal Contractor			
General Contractor			
Controls Contractor			
Electrical Contractor			
PAC Consultant			
NMPSFA RFM			
Manufacturer Rep.			

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

PRE-FUNCTIONAL CHECKLIST – TAB

PROJECT:

PROJECT NUMBER:

REPORT ID:

EQUIPMENT DESCRIPTION: Ductwork

TAG NO: N/A

LOCATION:

WEATHER CONDITIONS:

This Pre-Functional Checklist is used during the Performance Assurance Process to insure the correct equipment is delivered, installed and properly started in preparation for Functional Testing of related building systems. This checklist does not take the place of the Manufacturer's recommended checkout and startup procedures.

This Checklist is divided into 2 Sections and is to be completed by the Contractor in 2 separate steps. When completing each Section, be sure to check and initial EACH line item as being completed. Each Section's items must ALL be checked complete and initialed before the form is submitted to the PAC Authority. Any item which does not apply can be marked as "N/A" in the initial section. **If this form is not used for documenting, one approved by NMPSFA of similar rigor shall be used.**

This filled-out checklist has been reviewed with the exceptions noted below.

COMMENTS:

New Mexico Public School Facilities Authority
1312 Basehart Rd. SE, Suite 200
Albuquerque, NM 87106-4368

SECTION 1 – PRE-START CHECKS:

The Contractor shall have personnel with direct knowledge complete this checklist to verify that systems are installed, complete and operable, before the commencement of TAB work. Contractor shall be responsible for ensuring that work by subcontractors is completed and checked off. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed construction checklists for mechanical inspection of the project to establish to the satisfaction of all parties that the systems are ready for testing and balancing.

1.HVAC Units & Built-Up Units	Ready		Int.
	Yes	No	
a) GENERAL			
Louvers installed			
Manual dampers adjusted and locked			
Automatic dampers operating			
Housing construction complete			
Access doors closed			
Condensate drain piping and pan			
Free from dirt and debris			
b) FILTERS			
Type and size			
Number			
Clean			
Frame - Leakage			
Temporary			
c) COILS (HYDRONIC)			
Size and rows			
Fin spacing and condition			
Obstruction and / or debris			
Airflow and direction			
Piping leakage			
Correct piping connections and flow			
Valves open or set			
Air vents or steam traps			
Provisions made for TAB measurements			

	Ready		Int.
	Yes	No	
d) COILS (ELECTRIC)			
Sizes and construction			
Airflow direction			
Duct connections			
Safety switches			
Contactors and disconnect switches			
Electrical service and connections			
Obstruction and / or debris			
e) FANS			
Rotation			
Wheel clearance and balance			
Bearing and motor lubrication			
Drive alignment			
Belt tension			
Drive set screws tight			
Belt guard in place			
Flexible duct connector alignment			
Starters and disconnect switches			
Electrical service and connections			
f) VIBRATION ISOLATION			
Springs and compression			
Base level and free			

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Albuquerque, NM 87106-4368

PRE-FUNCTIONAL CHECKLIST – TAB

2. Duct Systems	Ready Yes	Ready No	Int.
a) GENERAL			
Manual dampers adjusted and locked			
Access doors closed and tight			
Fire dampers open and accessible			
Terminal units open or set			
Registers and diffusers open and set			
Turning vanes in square elbows			
Provisions made for TAB measurements			
Ductwork sealed as required			
b) ARCHITECTURAL			
Windows installed and closed			
Doors closed as required			
Ceiling plenums installed and sealed			
Access doors closed and tight			
Air shafts and openings as required			
3. Pumps			
a) MOTORS			
Rotation			
Lubrication			
Alignment			
Set screws tight			
Guards in place			
Starters and disconnect switches			
Electrical service and connections			

b) PIPING	Ready Yes	Ready No	Int.
Correct flow and connections			
Leakage			
Valves open or set			
Strainer clean			
Air vented			
Flexible connectors			
Cavitation possibilities			
c) BASES			
Vibration isolation			
Grouting			
Leveling			
4. Hydronic Equipment			
a) BOILERS			
Operating controls and devices			
Safety controls and devices			
Lubrication of fans and pumps			
Draft controls and devices			
Piping connections and flow			
Valves open or set			
Water make-up provisions			
Blow-down provisions			
Electrical connections			
b) HEAT EXCHANGERS			
Correct flow and connections			
Valves open or set			
Air vents or steam traps			
Leakage Provisions made for TAB measurements			

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PRE-FUNCTIONAL CHECKLIST – TAB

	Ready		Int.
	Yes	No	
c) COOLING TOWERS AND EVAPORATIVE CONDENSERS			
Correct flow and connections			
Valves open or set			
Leakage			
Provisions made for TAB measurements			
Sump water level			
Spray nozzles			
Fan / pump rotation			
Motor / fan lubrication			
Drives and alignment			
Guards in place			
Starters and disconnect switches			
Electrical connections			
5. Refrigeration Equipment			
Crankcase heaters energized			
Operating and safety controls and devices			
Valves open or set			
Piping connections and flow			
Flexible connectors			
Oil level and lubrication			
Guards in place			
Vibration isolation			
Starters, contactors and disconnect switches			
Electrical connections			

	Ready		Int.
	Yes	No	
6. Hydronic Piping Systems			
Leak tested and flushed			
Fluid levels and make-up			
Relief or safety valve settings			
Compression tanks / air vented			
Steam traps and connections			
Strainers clean			
Valves open or set			
Provisions made for TAB measurements			
7. Control Systems			
Data centers operating			
Outdoor / return dampers set			
Economizer controls set			
Static pressure control set			
Space controls operating			
Complete system operating			
8. Other Checks			
a) Other trade or personnel notified of TAB work requirements			
b) Preliminary data complete			
c) Test report forms prepared			

The above checklist items have been verified complete: _____YES / _____NO

SECTION 2 - NOTIFICATION FOR TESTING:

This piece of equipment is properly installed, has been properly started up and is operational and ready for performance testing.

ALL FIELDS MUST BE ENTERED. NO BLANKS. IF NOT INVOLVED, N/A.

RESPONSIBLE PARTY	VERIFIED BY (Name)	COMPANY	DATE
Mechanical Contractor			
Plumbing Contractor			
General Contractor			
Controls Contractor			
Electrical Contractor			
PAC Consultant			
TAB Contractor			
NMPSFA RFM			
Manufacturer Rep.			

SECTION 23 07 13 - DUCT INSULATION

PART 1 – GENERAL

1.1 SUMMARY

A. Furnish and Install

1. Ductwork insulation.

2. Duct liner.

3. Insulation jackets.

1.2 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.3 DESCRIPTION OF WORK

A. Work Included: The work included by this specification consists of furnishing all labor, accessories, equipment, and materials necessary for the installation of all insulation for ductwork and mechanical equipment in accordance with the specification and applicable drawings. This includes but is not limited to:

1. All supply ductwork

2. Return ductwork not within the conditioned space

3. All ductwork in the mechanical room

4. Outside air inlet ductwork that is within the conditioned space.

5. Mechanical equipment not factory insulated.

B. Do not internally insulate ductwork from evaporative coolers unless specifically indicated on the drawings.

C. Exterior duct wrap insulation with vapor barrier shall be used on all outdoor air ductwork within conditioned spaces.

D. Supply and return air ductwork shall be insulated with duct liner except in air handling systems having air washers or humidifiers. Where air washers or humidifiers are used, exterior duct insulation shall be used. Where duct liner is used, dimensions shown on the drawings shall be clear inside duct liner.

E. Testing:

1. All ductwork and mechanical equipment shall be tested for leakage and approved by the Architect/Engineer before any insulation is applied. The insulation contractor shall have this verified in writing before beginning work.

1.4 RELATED WORK IN OTHER SECTIONS

099000	PAINTING: PAINTING INSULATION JACKETS.
230000	HEATING, VENTILATING, AND AIR CONDITIONING INDEX
230500	GENERAL HEATING, VENTILATING, AND AIR CONDITIONING REQUIREMENTS
230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
233000	AIR DISTRIBUTION

1.5 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.

D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

E. ASTM E84 - Surface Burning Characteristics of Building Materials.

F. ASTM E96 - Water Vapor Transmission of Materials.

G. NFPA 255 - Surface Burning Characteristics of Building Materials.

H. SMACNA - HVAC Duct Construction Standards 1985 Ed. - Metal and Flexible.

I. UL 723 - Surface Burning Characteristics of Building Materials

1.6 DEFINITIONS

A. Exposed Location: Exposed in mechanical rooms or rooms with finished walls or ceilings.

B. Concealed Location: Located in pipe chase, furred spaces, attics, crawl spaces, above suspended ceilings in finished and unfinished rooms, or all other locations not exposed to view.

C. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. K Factors: All K Factors shown in the following specifications are expressed in BTU-in/hr-sq.ft-F.

1.7 SUBMITTALS

A. General: Comply with Section 230500.

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

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

1.8 QUALITY ASSURANCE

A. Regulatory Requirements Fire Hazard Classification: Insulation shall have a composite (insulation, jacket or facing, and adhesive to secure jacket or facing) fire hazard rating as tested by ASTM E84, NFPA 255, or UL 723 not to exceed 25 flame spread, 50 fuel contribution, and 50 smoke development. Materials shall be labeled accordingly.

B. Certifications of Insulation and Covering Materials: UL listed; flame spread/fuel contributed/smoke development rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723.

1.9 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum five years of documented experience.

1.10 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Comply with Section 230500. Deliver materials to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness. Store in a warm, dry location and protect against dirt, water, chemical, and mechanical damage.

1.11 PROJECT CONDITIONS

A. Manufacturer's Requirements: Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation while in storage.

B. Environmental Requirements: Perform work at ambient and equipment temperatures as recommended by the insulation manufacturer.

C. Protection: Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Repair or replace any such insulation or covering damaged prior to final acceptance of work.

1.12 WARRANTY

A. General: Satisfy requirements of Section 230500.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Owens-Corning Fiberglass Corporation.

2. Knauf.

3. Certainteed.

4. Manville.

2.2 INSULATION MATERIALS

A. Glass Fiber, Flexible:

1. Insulation: ASTM C-553; flexible, noncombustible blanket.

a) 'K' value: ASTM C518, of 0.29 at 75 degrees F.

b) Maximum service temperature: 250 degrees F.

c) Maximum moisture absorption: 0.20 percent by volume.

d) Density: 0.75 lb/cu ft.

2. Vapor Barrier Tape:

a) Kraft paper reinforced with glass fiber yarn and bonded to aluminum film.

3. Tie Wire: Annealed steel, 16-gage.

B. Glass Fiber, Rigid:

1. Insulation: ASTM C612; rigid, noncombustible blanket.

   a) 'K' value: ASTM C518, of 0.29 at 75 degrees F.

   b) Maximum service temperature: 250 degrees F.

   c) Maximum moisture absorption: 0.20 percent by volume.

   d) Density: 0.75 lb/cu ft.

2. Vapor Barrier Jacket:

   a) Kraft paper reinforced with glass fiber yarn and bonded to aluminum film.

   b) Moisture vapor Transmission: ASTM E96; 0.04 perm.

   c) Secure with pressure sensitive tape.

3. Vapor Barrier Tape:

   a) Kraft paper reinforced with glass fiber yarn and bonded to aluminum film, with pressure sensitive rubber-based adhesive.

C. Glass Fiber Duct Liner, Flexible

1. Insulation: ASTM C-553; flexible, noncombustible blanket.

   a) 'K' value: ASTM C518, of 0.28 at 75 degrees F.

   b) Maximum service temperature: 250 degrees F.

   c) Density: 2.0 lb/cu ft.

   d) Maximum Velocity on Coated Air Side: 4000 ft/min.

2. Adhesive

   a) Waterproof, fire-retardant type.

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

D. Glass Fiber Duct Liner, Rigid:

1. Insulation: ASTM C-612; flexible, noncombustible.

a) 'K' value: ASTM C518, of 0.23 at 75 degrees F.

b) Maximum service temperature: 250 degrees F.

c) Density: 2.0 lb/cu ft.

d) Maximum Velocity on Coated Air Side: 4000 ft/min.

2. Adhesive:

a) Waterproof, fire-retardant, type.

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

2.3 JACKETS

A. Canvas Jackets: UL listed.

1. Fabric: 6 oz/sq yd, plain weave cotton treated with dilute fire-retardant lagging adhesive.

2. Lagging Adhesive: Compatible with insulation.

B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.025-inch sheet.

2. Finish: Smooth or Corrugated.

3. Joining: Longitudinal slip joints and 2-inch laps.

4. Fittings: 0.016-inch-thick die shaped fittings covers with factory attached protective liner.

5. Metal Jacket Bands: 3/8-inch wide, 0.016-inch-thick aluminum.

6. Flexible glass fiber with fire resistant coating facing air stream; ASTM E-84/ASTM C518-70; 'k' value of 0.25 maximum at 75 F, 2 lb. density, one-inch thickness.

C. Type C: Neoprene faced, rigid glass fiberboard, 2 lb. density, ASTM E- 84/ASTM C-518; 'k' value of 0.23 at 75 F; one-inch thickness.

D. Jackets:

1. Interior Applications

a) Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.

2. Exterior Applications

a) Sheet metal enclosure of corrugated aluminum, 0.02 in. thick, with metal jacket bands: 3/8 inch wide, 0.016 thick aluminum; or stick clips with smooth finish.

2.4 ACCESSORIES

A. Impale Anchors: Galvanized steel, 12-gage, self-adhesive pad and press on washer head.

B. Joint Tape: Glass fiber cloth, open mesh.

C. Lagging Adhesive: Fire resistive to ASTM E-84 or NFPA 255 or UL 723.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

A. General

1. Applications: Apply insulation tightly over clean, dry surfaces with sections or edges firmly butted together or lapped. Make insulation continuous through sleeves or openings in walls or floors.

2. Vapor Barriers: Seal vapor barriers and run continuous throughout for heated and cooled supply air ductwork.

3. Finishes: Finish insulation neatly at hangers, supports and other protrusions. Locate insulation or cover seams in least visible locations.

4. Installation Repairs: Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

5. Exterior Locations: Re-cover with corrugated aluminum jacket attached with suitable aluminum rivets.

6. Manufacturer's Instructions: Install materials in accordance with manufacturer's instructions.

7. Thermal Units: Provide insulation with vapor barrier on ductwork downstream of fan coil terminal units.

8. Factory Insulated Equipment: Do not insulate factory-insulated equipment.

9. Attachment: Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

10. Cement and Fillers: Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

11. Placards: Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such nameplate or any operable device.

12. Service Access: When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

13. Insulation shall be installed in a workmanlike manner by workmen regularly engaged in this type of work. Insulation shall not be applied until all surfaces are clean and dry and until inspection and release for insulation application.
14. A complete moisture and vapor seal shall be provided on cold surfaces where vapor barrier jackets or coatings are required. Anchors, hangers, and other projections shall be insulated, and vapor sealed to prevent condensation.

15. Duct insulation shall be continuous through walls and floor openings except where walls or floors are required to be fire stopped or required to have a fire resistance rating.

B. Locations for Insulation:

1. External: Outside of ducts not internally lined, located interior of building, in mechanical room.

    a) Rectangular: 1-1/2-inch-thick glass fiber insulation. Fasten to duct with weld pins or stock clips spaced 12 inches to 18 inches o.c. with minimum of two rows per side of duct. Secure with washers firmly embedded in insulation. Seal joints, breaks, and punctures in

cold air ductwork wire fire-retardant vapor adhesive reinforced with a three-inch wide strip similar to that of facing.

b) Round: Two-inches thick glass fiber blanket duct wrap. Adhere insulation to duct with fire retardant adhesive applied in bands around the duct. Butt tight with facing overlapping all joints at least two inches. Seal cold air ductwork with fire retardant vapor barrier adhesive. Seal breaks and punctures in the facing of cold air ductwork with vapor barrier tape sealed with fire retardant adhesive.

2. For exterior applications, provide insulation with vapor barrier jacket w/2" thick rigid insulation w/minimum R-value of 8. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

3. Insulation below grade shall be polyurethane spray foam, suitable for use in wet environments without degradation and having the following properties.

a) All duct shall be supported on 2" thick rigid polystyrene board exceeding the width of the duct. Spray foam shall be applied to assure a 2" MINIMUM coverage. Insulation shall be coated with Deer-O Foam Cap W-256 applied at the rate of one gallon per 100 square ft. for vapor barrier protection with a perm rating of 0.00019.

C. Duct Liner

1. Duct liner shall be installed in accordance with Figures 6-1 through 607 of the SMACNA High Velocity Duct Manual and the Manufacturer's recommendations.

END OF SECTION 23 07 13

SECTION 23 30 00 - AIR DISTRIBUTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Furnish and install fans, filters, sheet metal work, grilles, louvers, diffusers, registers, sound traps, special fan bases, fire dampers, combination fire and smoke dampers and sleeves, accessories and natural gas fired appliance flue vents.

B. All automatically controlled dampers furnished under Section 253000 - CONTROLS AND INSTRUMENTATION will be installed under this section. After dampers are set, they shall be balanced for free and easy operation.

C. Where ductwork has an interior lining, dimensions shown on drawings shall be clear dimensions inside the liner.

D. Prior to system test and balance, supply and install new, clean air filters throughout the air handling systems except for any high efficiency filters, which have pressure drop within normal operating limits.

1.3 REQUIREMENTS AND RELATED WORK

230000	HEATING, VENTILATING, AND AIR CONDITIONING INDEX
230500	GENERAL HEATING, VENTILATING AND AIR CONDITIONING REQUIREMENTS
230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230593	BALANCING OF MECHANICAL SYSTEMS
230713	DUCT INSULATION
253000	CONTROLS AND INSTRUMENTATION

1.4 REFERENCES

A. ASTM A 36 - Structural Steel

B. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

C. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

D. ASTM A 366 - Steel, Sheet, Carbon, Cold Rolled, Commercial Quality

E. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

F. ASTM A 525 - General Requirements for Steel Sheet, Zinc- Coated (Galvanized) by the Hot-Dip Process

G. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality

H. ASTM A 568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled

I. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality

J. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

K. AWS D9.1 - Welding of Sheet Metal

L. NFPA 90A - Installation of Air Conditioning and Ventilating Systems - Latest Edition

M. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems -Latest Edition.

N. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying - Latest Edition

O. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment - Latest Edition

P. SMACNA - HVAC Air Duct Leakage Test Manual

Q. SMACNA - HVAC Duct Construction Standards - Metal and Flexible – 1985

R. UL STANDARD 181 - Factory-Made Air Ducts and Connectors

S. UL STANDARD 555 – Standard for Safety Fire Dampers

T. UL STANDARD 555S – Leakage Rated Dampers for use in Smoke Control Systems

PART 2 – PRODUCTS

2.1 EQUIPMENT SCHEDULES

A. All major items of equipment are specified in the equipment schedule on the drawings and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory operating system.

B. All registers, grilles and diffusers shall be as listed in the schedule on the drawings. Frame style shall be coordinated by the Contractor to match the ceiling type shown on the reflected ceiling plans of the Contract Documents.

2.2 DUCTWORK

A. SHEET METAL

1. Materials and Gauges: Construct all ducts, casings, plenums, etc., of galvanized steel sheets, of the gauges specified below, unless otherwise shown. Sheets shall be free from blisters, slivers, pits and imperfectly galvanized spots.

2. All ductwork shall be constructed in accordance with "HVAC DUCT CONSTRUCTION STANDARDS - METAL AND FLEXIBLE". First Edition, 1985 as published by Sheet Metal and Air Conditioning Contractors National Association, Inc. Pressure class for all ductwork shall be 2” or unless otherwise noted on plans.

3. Construct low velocity ducts using Pittsburgh or "Snap-Lock" corner seams. All seams shall be made airtight. Using United Mc Grill “UNI-FLEX” duct sealer or approved equal.

4. Connections of high pressure and/or velocity ducts, fittings and high-pressure boxes shall be made airtight by tack welding on 8" centers and coating joints with United Mc Grill “United duct Sealer”.

5. Round ducts and fittings for high velocity systems shall be spiral lock seam conduit as manufactured by United Mc Grill Co., Inc., or approved equal. All 90 elbows shall be at least 5-piece construction. Standard manufactured ducts of other than spiral construction will be acceptable if constructed of the following gauges with welded seams. Sizes thru 12-inch diameter shall be 22-gauge, 13 inch thru 36-inch diameter shall be 20 gauge, 37 inches and over shall be 18 gauge. Basic high velocity fittings are detailed on the drawings. Spun or tapered takeoffs shall be used from all vertical high velocity risers.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 time’s width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

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

D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4-inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45-degree lateral wye takeoffs unless otherwise indicated where 90-degree conical tee connections may be used.

F. FLEXIBLE

1. Flexible ducts for connections between rigid ductwork and variable volume boxes shall be Factory Insulated flexible conduit capable of holding 5 inches W.C. without development leaks and shall not exceed a flame spread of 25 or a smoke development of 50. Thermo flex Type N-KH or approved equal.

2. Flexible connections between the diffusers and the run-out ducts shall be factory insulated, sound absorbing low velocity flexible conduit conforming to the following duct fabrication shall not exceed a flame spread of 25 or a smoke development of 50.

   a) Two ply vinyl film supported by helically wound spring steel wire: fiberglass insulation: polyethylene vapor barrier film.

   b) Pressure Rating: 10 inches WG (2.50 kPa) positive and 1.0 inches WG (250 Pa) negative.

   c) Maximum Velocity: 4000 fpm (20.3 m/sec).

   d) Temperature Range: -10 degrees F to 160 degrees F (-23 degrees C to 71 degrees C).

2.3 COMBINATION FIRE/SMOKE DAMPERS

A. Furnish and install at locations shown on plans, or as required by code combination fire/smoke dampers meeting the following specifications. Frame shall be galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement.

B. Each combination fire smoke damper shall be 1-1/2-hour fire rated under UL Standard 555 or greater where noted on architectural plans and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. The leakage rating under UL555S shall be Leakage Class II (10 cfm/ft. at 1" w.g.)

C. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250º F, 350ºF, or 450ºF depending upon the actuator. Appropriate electric "Firestat" operator shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Manufacturer shall provide factory assembled sleeve of 16" minimum length (contractor to verify requirement). Factory supplied caulked sleeve shall be 16-gage for dampers up to 36" wide by 24" tall and 14-gage above 36" wide X 24" tall.

   1. Combination Fire/Smoke dampers shall be Ruskin FSD6O rectangular dampers and Ruskin FSDR25 for round dampers or approved equal with correct mounting frames and sleeves for actual installation.

   2. Combination Fire/Smoke dampers for corridors ceiling shall be Ruskin FSD36 with internally mounted actuator.

D. Each combination fire and smoke damper shall include an integral factory furnished and installed duct smoke detector compatible with the building fire alarm system. Assembly by Ruskin DSDN or approved equal.

E. Size of access doors in ductwork shall be 2 inches less than the width of the duct by 12 inches, up to a maximum size of 24 inches by 24 inches.

2.4 FIRE DAMPERS

A. Furnish and install at locations shown on the drawings or as required by code fire dampers meeting the following requirements. Provide access doors at all fire damper locations of sufficient size to allow easy resetting of fire damper linkage. Fire damper links shall be of the test strength recommended to prevent nuisance closing. All fire dampers shall conform to the requirements of NFPA Pamphlet 90A and shall meet the required UL Standard 555.

B. High Velocity Round or Oval Fire Dampers: High velocity fire dampers shall be of the folding blade type designed for minimum static pressure drop. Fusible links shall be accessible from either side of the damper. Each damper shall be furnished complete with a galvanized welded steel sleeve (round or oval) and closure compartment to house the folded blades. Fire dampers shall be Ruskin FD35 with 165°F fusible link or approved equal.

C. Rectangular Fire Dampers: Fire dampers for rectangular ductwork shall be of the folding blade type with the hinged blades completely out of the air stream of the single hinged blade type. Fusible links shall be accessible from either side of the damper. Each damper shall have a galvanized welded steel sleeve (rectangular or square) and closure compartment to house the folded blades. Rectangular fire dampers mounted in the horizontal plane are to be spring loaded. Fire dampers shall be Ruskin DIBD with 165°F fusible link or approved equal.

D. Provide access doors at all fire damper locations of sufficient size to allow easy resetting of fire damper linkage. Size of access doors in ductwork shall be 2 inches less than the width of the duct by 12 inches, up to a maximum size of 24 inches by 24 inches.

E. Each fire damper shall be provided with spare fusible link(s) secured to the damper.

2.5 ACCESS DOORS

A. Wall and Ceiling Access Doors: Furnish as required in Section 230500, paragraph 3.6.

B. Duct Access Doors: Duct access doors at fire dampers and other locations which require access to mechanical devices inside of ductwork shall be Controlair 16-gauge access door with continuous hinge, neoprene gasket, thumb screw locks and baked enamel finish. Doors shall be sized for easy access to mechanical device.

C. Walk Thru Plenum Access Doors: Doors shall be provided with a flat iron or angle iron stiffening frame and so constructed that they can be operated without twisting or distortion. Doors on insulated ductwork shall be of double panel construction provided with an approved type insulated filler, not less than one inch thick. The duct opening at each door shall be provided with a continuous reinforcing galvanized bar or angle against which the door will close, this being provided with a sponge rubber gasket to make the door airtight.

D. Doorframes on insulated ductwork shall be placed on an extended metal collar flush with the face of the finished insulation.

E. Latches shall be operable from either side of door and shall be "Ventlok" No. 310.

2.6 BURIED UNDERGROUND DUCTS

A. Buried ducts may be concrete encased sheet metal PVC jacketed sheet metal as indicated.
B. Fabricate metal ductwork in accordance with SMACNA Low Pressure Duct Construction Standards, except as indicated. Fabricate using two gages heavier material than indicated for 2-inch WG pressure class.

2.7 FILTERS

A. Filters shall be as listed in the schedule on the drawings.

B. Filter gauge for each bank of filters in the mechanical rooms and roof top equipment will be supplied and installed by the Controls Contractor as specified in Section 253000 - CONTROLS AND INSTRUMENTATION.

2.8 COILS

A. In no case shall specified air or water pressure drops be exceeded more than 10%. Piping connections shall be as shown on the drawings. Coils shall be as specified in the equipment schedule on the drawings. In no case shall rows or fin spacing be less than the minimum surface scheduled.

2.9 TURNING VANES

A. Turning vanes shall be installed in all square elbows. Turning Vanes shall be air foil blade type, shop or factory fabricated.

2.10 FLUE GAS VENTS

A. Gas fired equipment shall be vented in accordance with the Uniform Mechanical Code, Uniform Plumbing Code and local codes and ordinances. Natural draft appliances shall have Type “B” vents. Forced draft appliances shall have ...[...Metalbestos Type PS, 16-gauge black steel...]...vents.

2.11 FAN PLENUMS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.

B. Mount floor mounted casings on 4-inch 100 high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gauge galvanized expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

C. Reinforce doorframes with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. [Provide clear wire glass observation ports, minimum 6 X 6-inch size.]

D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge back facing and 22 gage perforated front facing with 3/32-inch diameter holes on 5/32-inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber media, on inverted channels of 16 gauge.

E. Plenum Access Doors: As indicated on the drawings, provide, and install sheet metal access doors of the size as noted or as required for proper access to the equipment. These doors shall be constructed as integral parts of the plenum walls. Fasteners: Walk-thru type doors at plenum chambers shall be provided with two fastening devices equal to Ventlok #301 that can be operated on either side of the door. These devices are to be readily operated and moving parts to have bronze pins.

PART 3 – EXECUTION

3.1 INSTALLATION OF SHEET METAL WORK

A. All necessary allowance and provisions shall be made in the installation of sheet metal ducts for the structural conditions of the building, and ducts shall be transformed or divided as may be required. Whenever this is necessary the required area shall be maintained. All of these changes, however, must be approved and installed as directed at the project. During the installation, the open ends of ducts shall be protected to prevent debris and dirt from entering. Whenever exposed ducts pass through walls, floors or ceilings, a flanged sheet metal collar fitting close around ducts shall be slipped along duct until flange is tight against finished surface covering edges of openings and presenting a neat appearance. Collar shall be locked to duct.

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

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

D. Connect diffusers or light troffer boots to low-pressure ducts with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.

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

F. Encase buried metal ductwork in 3-inch minimum of concrete. Provide adequate tie-down points to prevent ducts from floating during concrete placement. Introduce no heat into ducts for 20 days following placement of concrete.

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

H. All ducts, coils, housings, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening.

3.2 DUCTS AT MASONRY

A. Where ducts are shown connecting to masonry openings and along edges of all plenums at floors and walls, provide a continuous 2" x 2" x 1/8" galvanized angle iron which shall be bolted to the construction and made airtight to the same by applying caulking compound. Sheet metal in these locations shall be bolted to the angle iron.

3.3 HAND AND SPLITTER DAMPERS

A. Install hand operated volume and splitter dampers at all locations of branches of main ducts, from equipment, supply ducts, return ducts and at all locations where air flow splits or is balanced, whether shown or not. Volume dampers shall be controlled by heavy duty locking quadrants mounted on the outside of the duct. Where ducts are insulated the damper rod shall be extended and the operator shall be mounted on the outside of the insulation. Where volume dampers are installed in ducts over 12" deep, the dampers shall be made in two sections and each independently operated. Splitter dampers shall be at least 1 1/2 times as long as the narrowest adjacent split. All damper fittings must be heavy commercial items and must be approved by the Architect/Engineer before installation.

3.4 FLEXIBLE CONNECTIONS

A. Provide glass fabric, neoprene coated flexible connections, not less than 6" wide at the inlet and outlet connection of each fan unit, securely fastened to the unit and to the ductwork. Material shall comply with Underwriter's Laboratories Standard 214.

B. Indoor applications shall have Metaledge Ventglas with heavy glass fabric, double coated with Dupont's Neoprene.

C. Outdoor applications shall have Metaledge Ventlon with heavy glass fabric, double coated with Dupont's Hypalon.

3.5 CROSS BREAKING

A. Rectangular sheet metal ducts shall be cross-broken on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts shall be cross-broken. Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross break shall be of the required height to assure surfaces being rigid. High velocity plenum panels and ductwork shall not be cross-broken.

3.6 TEST HOLES IN DUCTWORK

A. Furnish test holes in ducts at locations required by the testing and balancing team for testing of air quantities in ducts. Ventlok No. 699, closures shall be provided and installed for each test hole, with sufficient neck length to penetrate the insulation.

3.7 HANGERS AND SUPPORTS

A. Hangers for ducts up to 18 inches in width or diameter shall be placed not more than ten-foot centers. Ducts 19 inches and over in width or diameter shall be supported on not more than five-foot centers. Hangers shall be placed plumb and present for a neat appearance. Construct hangers for high velocity boxes and for ductwork form galvanized iron 1" x 1" x 1/16" for ducts up to 36 inches in width or diameter. For ducts over 36 inches in width or diameter, support ducts every 4'-0" with 1 1/4" x 1 1/2" x 1/8" angles. The use of perforated band iron for duct support is prohibited. Hangers shall extend down the sides of the ducts using not less than three rivets or parker screws of appropriate sizes. It is essential that all ducts be rigidly supported. Where vertical ducts pass thru floors or roofs heavy supporting angles shall be attached to ducts and to the structure. Angles shall be of sufficient size to support ductwork rigidly. Place supporting angles on at least two sides of the duct.

3.8 FABRICATION

A. All ductwork shall be fabricated with the mill markings on the outside.

3.9 TESTS

A. Testing and balancing of the air tempering systems will be as specified in Section 230593 - BALANCING OF MECHANICAL SYSTEMS.

B. If specified conditions cannot be obtained due to deficiencies in equipment performance or improper installation or workmanship, the Mechanical Contractor shall make any changes necessary to provide the specified conditions.

C. Cleaning ducts and testing for tightness: Before the ceiling is installed and final connections are made to air outlet devices, operate the fans at full capacity to blow out dirt and debris from the ducts. If it is not practical to use the main supply blower for cleaning, the ducts may be blown out in sections by a portable fan. After the ducts have been cleaned, an air tightness test shall be made on all ductwork. A minimum pressure equal to fan static pressure at less than 10% of design flow or 2 1/2 times design external static pressure, whichever is less shall be maintained during the test. A soap test shall be applied to all sheet metal connections and joints to locate air leaks. Air leaks which are in excess of that required to bubble the soap suds (that is, actually blow the suds away), shall be sealed by additional taping and caulking to reduce the leakage to a rate not to exceed slow bubbles forming. In lieu of the above tightness tests, the Contractor may test the ducts by attaching a fan with a capacity of not over 300 cfm at 2 1/2" static pressure to the ductwork and with outlets blocked airtight, build up the pressure in the ducts to 2" water gauge. If this pressure cannot be obtained the Contractor shall locate and repair the leaks as specified above. The Architect/Engineer and Owner's Representative shall witness the test and the Contractor shall notify the Insulation Contractor in writing when the test has been satisfactorily completed.

END OF SECTION 23 30 00

SECTION 25 00 00 - INTEGRATED AUTOMATION INDEX

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Furnish all service tools, equipment, etc., which are required for the complete installation of all Integrated Automation Work, as indicated on the Drawings, and specified herein. Integrated Automation work indicated on the Drawings and/or specifications covering other trades shall conform to Division 25 of these Specifications.

B. Work or equipment not indicated or specified, which is necessary for the complete and proper operation of the Integrated Automation systems shall be accomplished without additional cost to the Owner.

C. Furnish all labor and materials required for Integrated Automation service connections to all the various items of equipment requiring controls service throughout the project shown on the Contract Drawings (even if not shown on Integrated Automation Drawings). Coordinate with other trades for the installation of required connections and service.

1.3 INTEGRATED AUTOMATION DIVISION INDEX

250500	GENERAL INTEGRATED AUTOMATION REQUIREMENTS
251000	DIRECT DIGITAL CONTROL (DDC) SOFTWARE AND COMPONENTS
256000	MECHANICAL AND ELECTRICAL COORDINATION SCHEDULE

PART 2 – PRODUCTS: Not Used.

PART 3 – EXECUTION: Not Used.

END OF SECTION 25 00 00

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Or Engineer approved equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 26050

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

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

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.2 CONNECTORS AND SPLICES

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

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. No wire smaller than No. 12 AWG shall be permitted.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway; Type XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway; Metal-clad cable, Type MC for fixture whips only.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-

THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: A qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to

achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

B. The conduit systems and neutral conductors of the wiring system shall be grounded. The ground connection of the electrical system, neutral ground wire system and conduit system shall be made at the main service device. The incoming cold water system, primary ground, neutral conduit system and metallic grounding system shall be bonded.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Conductor: Conductor size per the construction documents or as required by NEC Article 250.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 5/8 by 96 inches (16 by 2400 mm) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 30 inches (750 mm) below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except as otherwise indicated.
3. Connections to Ground Rods: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may

be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 2 AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.4 FIELD QUALITY CONTROL

A. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A.

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.
h. Engineer approved equal.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or

cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
        5) Engineer approved equal.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.
        6) Engineer approved equal.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, or spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

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

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

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

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

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. LFNC: Liquidtight flexible nonmetallic conduit.

F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.
10. Engineer approved equal.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. EMT: ANSI C80.3.

E. FMC: Zinc-coated steel or aluminum.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Fittings for EMT: Die-cast, compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.

8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.
13. Engineer approved equal.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.
4. Engineer approved equal.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
14. Engineer approved equal.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Nonmetallic Floor Boxes: semi-adjustable, rectangular.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with vehicular traffic rating Tier 5.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.
e. Quazite
f. Engineer approved equal.

2.6 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.
5. Engineer approved equal.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Plastic. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing

element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit or IMC.
2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC or EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:

    a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
    b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
    c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit or IMC.

C. Minimum Raceway Size: 1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from RNC, Type EPC-40-PVC to rigid steel conduit, IMC or EMT before rising above the floor.

I. Raceway Terminations at all locations: Use insulating bushings to protect conductors.

J. Install pull wires in empty raceways. Use Tru-Tape pull strings with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in all wet or damp locations.

L. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

M. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand-tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured rigid steel wrapped conduit elbows for stub-ups at poles and equipment and at building entrances through the floor. Conduit elbows installed in direct contact with the earth shall be rigid galvanized steel, field-wrapped with one layer of 3M Scotch 50 plastic tape with a 50 percent overlap, including all joints or couplings, or shall be coated with a bonded, 20 mil minimum thickness, PVC, permanently fused at the factory, Pittsburgh Standard Co. "Plastibond" or approved equal.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Tape: Bury warning tape approximately 12 inches above direct-buried conduits. Align warning tape along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 24” below grade.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping

specified in Division 07 Section "Penetration Firestopping."

B Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

1.1 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

1.2 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

1.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes and standards. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.2 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
3. As directed by Architect and/or Engineer.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

C. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.6 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or

taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

   a. Indoor Equipment: Adhesive film label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Switchgear.
   e. Switchboards.
   f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   g. Enclosed switches.
   h. Enclosed circuit breakers.
   i. Enclosed controllers.
   j. Variable-speed controllers.
   k. Push-button stations.
   l. Power transfer equipment.
   m. Contactors.
   n. Remote-controlled switches, dimmer modules, and control devices.
   o. Receptacles (on front of coverplate).

3. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be pretensioned, snap-a-round, colored plastic sleeves, colored adhesive marking tape, or a combination of the

two. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:
a. Fire Alarm System: Red
b. Security Alarm Systems: Blue and Yellow
c. Mechanical and Electrical Supervisory System: Green and Blue
d. Data System: Green and Yellow
e. TV Systems: Green
f. Sound/PA: Orange
g. Telephone: Orange and Yellow
h. 120/208V Power: Black
i. 277/480V Power: Blue
j. 120/208V Emergency Power: Black and Orange
k. 277/480V Emergency Power: Blue and Orange

4. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations or similar labels.

5. Use conductors with color factory-applied the entire length of the conductors except as follows under which conditions field applied color-coding methods may be used in lieu of factory-coded sire for sizes larger than No. 10 AWG:
   a. Apply colored, pressure-sensitive plastic tape in half–lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch- wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

6. Tag or label conductors as follows:
   a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
   b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure, label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
   c. Fiber Optic Cable and conduit: All fiber optic cable shall bear factory printed cable identification marking indicating the cable is “fiber optic”. Install permanent ink markings indicating the words “fiber optic” on colored tape or tags to this effect on conduit runs containing fiber optic cable at changes in direction, at penetrations of walls and floors (each side), at junction boxes and termination, and at 40 foot maximum intervals.

END OF SECTION 260553

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. ACME Electric Corporation; Power Distribution Products Division.
2. Powersmith
3. Controlled Power Company.
4. General Electric Company.
5. Myers Power Products, Inc.
6. Siemens Energy & Automation, Inc.
7. Sola/Hevi-Duty.
8. Square D; Schneider Electric.
9. Engineer approved equal

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

    a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
    b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
    c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

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

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Panelboard Schedules: For installation in panelboards.

D. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect and Owner no fewer than three days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's or Owner's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: See panel schedules on construction documents for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R Gasketed or NEMA 4.
c. Kitchen Areas: NEMA 250, NEMA 3R.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Door in Door Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor as per the construction documents.
5. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

6. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Per construction documents.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton (Cutler-Hammer).
2. Engineer approved equal.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker, fused switch or lugs as per the construction documents.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Branch Overcurrent Protective Devices: Fused switches.

H. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. External Control-Power Source: 120-V branch circuit.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton (Cutler-Hammer).
2. Engineer approved equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. External Control-Power Source: 120-V branch circuit.

F. Door in Door Construction: Concealed hinges; secured with flush latch with tumbler lock; keyed alike. No EZ trim.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton (Cutler-Hammer).
2. Engineer approved equal.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

2.5 PANELBOARD SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton (Cutler-Hammer).
3. Engineer approved equal.

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

a. Fuses rated at 200-kA interrupting capacity.
b. Fabrication using bolted compression lugs for internal wiring.
c. Integral disconnect switch.
d. Redundant suppression circuits.
e. Redundant replaceable modules.
f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
g. LED indicator lights for power and protection status.
h. Audible alarm, with silencing switch, to indicate when protection has failed.
i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
j. Four-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

    a. Line to Neutral: 70,000 A.
    b. Line to Ground: 70,000 A.
    c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:

    a. Line to Neutral: 400 V for 208Y/120.
    b. Line to Ground: 400 V for 208Y/120.
    c. Neutral to Ground: 400 V for 208Y/120.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Isolated-ground receptacles.
5. Snap switches and wall-box dimmers.
6. Solid-state fan speed controls.
7. Communications outlets.
8. Pendant cord-connector devices.
9. Cord and plug sets.
10. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
5. Engineer approved equal.

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).
e. Engineer approved equal.

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

    a. Cooper; TR8300.
    b. Hubbell; HBL8300SG.
    c. Leviton; 8300-SGG.
    d. Pass & Seymour; 63H.
    e. Engineer approved equal.

3. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

    a. Cooper; GF20.
    b. Pass & Seymour; 2084.
    c. Engineer approved equal.

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

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

    a. Cooper; 5362BLS.

b. Hubbell; HBL5362SA.
c. Leviton; 5380.
d. Engineer approved equal.

3. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

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

a. Cooper; L520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.
e. Engineer approved equal.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

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

    a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
    b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
    c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
    d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
    e. Engineer approved equal.

C. Pilot Light Switches, 20 A:

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

    a. Cooper; 2221PL for 120 V and 277 V.
    b. Hubbell; HPL1221PL for 120 V and 277 V.
    c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
    d. Pass & Seymour; PS20AC1-PLR for 120 V.
    e. Engineer approved equal.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

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

    a. Leviton; 1221-2L.

3. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with

UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices.
2. As per construction documents.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 CCUPANCY SENSORS

A. Wall or Ceiling Sensors:

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

a. Cooper
b. Hubbell
c. Leviton
d. Pass & Seymour
e. Watt Stopper (The)
f. Engineer approved equal.

2.11 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch thick, satin-finished stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof While In Use Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.12 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

2.13 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. TVSS Devices: Blue.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use machine printing with black lettering on face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION 26 27 26

SECTION 264313 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Sections:

1. Division 26 Section "Switchboards" for factory-installed TVSS.
2. Division 26 Section "Panelboards" for factory-installed TVSS.
3. Division 26 Section "Wiring Devices" for devices with integral TVSS.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.

C. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. Comply with NEMA LS 1.

D. Comply with UL 1283 and UL 1449.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect or Owner no fewer than three days in advance of proposed electrical service interruptions.
2. Do not proceed with interruption of electrical service without Architect's or Owner's written permission.

B. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, non-condensing.
4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

A. Coordinate location of field-mounted TVSS devices to allow adequate clearances for maintenance.

B. Coordinate TVSS devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fails in materials or workmanship within specified warranty period.

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

B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 SERVICE ENTRANCE SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ABB USA.
2. AC Data Solutions.

3. Advanced Protection Technologies Inc. (APT).
4. Atlantic Scientific.
5. Current Technology Inc.; Danaher Power Solutions.
6. Danaher Power Solutions; United Power Products.
7. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
8. Intermatic, Inc.
9. LEA International.
10. Leviton Mfg. Company Inc.
11. Liebert Corporation; a division of Emerson Network Power.
12. Northern Technologies, Inc.; a division of Emerson Network Power.
13. Siemens Energy & Automation, Inc.
14. Square D; a brand of Schneider Electric.
15. Surge Suppression Incorporated.
16. Engineer approved equal.

B. Surge Protection Devices:

1. Non-modular.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Surge Protection Devices:

1. Comply with UL 1449.
2. Modular design (with field-replaceable modules).
3. Fuses, rated at 200-kA interrupting capacity.
4. Fabrication using bolted compression lugs for internal wiring.
5. Integral disconnect switch.
6. Redundant suppression circuits.
7. Redundant replaceable modules.
8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
10. LED indicator lights for power and protection status.
11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
13. Four-digit transient-event counter set to totalize transient surges.

D. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

E. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2

1. Line to Neutral: 70,000 A.
2. Line to Ground: 70,000 A.
3. Neutral to Ground: 50,000 A.

F. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120 V.
2. Line to Ground: 400 V for 208Y/120 V.
3. Neutral to Ground: 400 V for 208Y/120 V.

1.10 PANELBOARD SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ABB USA.
2. AC Data Solutions.
3. Advanced Protection Technologies Inc. (APT).
4. Atlantic Scientific.
5. Current Technology Inc.; Danaher Power Solutions.
6. Danaher Power Solutions; United Power Products.
7. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
8. Intermatic, Inc.
9. LEA International.
10. Leviton Mfg. Company Inc.
11. Liebert Corporation; a division of Emerson Network Power.
12. Northern Technologies, Inc.; a division of Emerson Network Power.
13. Siemens Energy & Automation, Inc.
14. Square D; a brand of Schneider Electric.
15. Surge Suppression Incorporated.
16. Engineer approved equal.

B. Surge Protection Devices:

1. Non-modular.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Surge Protection Devices:

1. Comply with UL 1449.
2. Modular design (with field-replaceable modules).
3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
4. Fuses, rated at 200-kA interrupting capacity.
5. Fabrication using bolted compression lugs for internal wiring.
6. Integral disconnect switch.
7. Redundant suppression circuits.
8. Redundant replaceable modules.
9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
10. LED indicator lights for power and protection status.

11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
13. Four-digit transient-event counter set to totalize transient surges.

D. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

E. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:

1. Line to Neutral: 70,000 A.
2. Line to Ground: 70,000 A.
3. Neutral to Ground: 50,000 A.

F. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120 V.
2. Line to Ground: 400 V for 208Y/120 V.
3. Neutral to Ground: 400 V for 208Y/120 V.

1.11 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

B. Outdoor Enclosures: NEMA 250 Type 3R.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multiple, 30-A circuit breaker as a dedicated disconnecting means for TVSS unless otherwise indicated.

2.2 STARTUP SERVICE

A. Do not energize or connect service entrance equipment and panelboards to their sources until TVSS devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

2.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain TVSS devices.

END OF SECTION 264313

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. CU: Coefficient of utilization.

C. LER: Luminaire efficacy rating.

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

E. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. LED Drivers.
4. Energy-efficiency data.
5. Life, output, and energy-efficiency data for lamps and drivers.
6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.

C. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: One years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency LED and Self-Powered Exit Sign Batteries: One years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for LED Drivers: Manufacturer's standard form in which driver manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
3. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
b. UV stabilized.

2.3 EMERGENCY LED POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with driver. Comply with UL 924.

1. Emergency Connection: Operate all lamps continuously at rated output of fixture. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
5. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.4 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared

receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 EMERGENCY LIGHTING UNITS

A. Description: Self-contained LED units complying with UL 924.

1. Battery: Sealed, maintenance-free, Nickel cadmium type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install 4 independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Fixtures are to be secured to structure and not lay-in ceiling system grids.

D. Adjust aimable lighting fixtures to provide required light intensities.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge or LED as approved.

C. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. Standard: Same definition as "Pole" above.

1.4 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
3. Wiring Diagrams: Power and control wiring.

C. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: One year from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: One year from date of Substantial Completion.
3. Warranty Period for Color Retention: One year from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
3. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors unless otherwise indicated.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: as indicated.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.5 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

C. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.

a. Restrike Range: 105- to 130-V ac.
b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Minimum Starting Temperature: Minus 40 deg F.

2.6 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

B. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

C. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

D. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.8 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Round, straight or Square, straight as indicated on construction documents.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: as indicated on construction documents. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with galvanized-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching

grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

2.9 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Round, straight or Square, straight as indicated on the construction documents.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

    a. Color: As selected by Architect from manufacturer's full range.

2.10 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, 12 inches above finished grade.
2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, Insert color to match pole, that when mounted results in NEMA 250, Type 3R enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s).

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers, unless otherwise indicated.
4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding conductor and conductor protector.
2. Ground metallic components of pole accessories and foundations.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 56 00

SECTION 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.

1.03 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

A. Product Data: For sleeve seals.

1.05 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

PART 2 - PRODUCTS

2.01 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, EMT, Rigid, IMC, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE SEAL

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, Hilti FS-One Intumescent Firestop, CFS-BL Firestop Block.

2. Basis-of-Design Product: Subject to compliance with requirements, Hilti FS-One Intumescent Firestop, CFS-BL Firestop Block. or comparable product by one of the following:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

e. Hilti

3. Sealing Elements: [**EPDM**] [**NBR**] interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.

4. Pressure Plates: [**Plastic**] [**Carbon steel**] [**Stainless steel**]. Include two for each sealing element.

5. Connecting Bolts and Nuts: [**Carbon steel with corrosion-resistant coating**] [**Stainless steel**] of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in

such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.02 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 4" Rigid / IMC/ EMT per NEC code requirements. Min 6" and 12" max above finished floor level.

G. Size pipe sleeves to provide 1-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.03 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.04 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.

Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION

SECTION 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

B. Related Sections:

1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
3. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.03 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches in width.

D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

1.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

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

1.05 SUBMITTAL

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: APS Requirement: 2 RCDD's, Bicsi Certified Technicians and Bicsi Installers, qualified layout technician, installation supervisor, and field inspector.

D. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

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

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.08 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cable Management Solutions, Inc.
   b. Cablofil Inc.
   c. Cooper B-Line, Inc.
   d. Cope - Tyco/Allied Tube & Conduit.
   e. GS Metals Corp.
2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.
   a. Basket Cable Trays: Wire mesh spacing shall not exceed 2 by 4 inches.
   b. Trough Cable Trays: Nominally 6 inches wide.

c. Ladder Cable Trays: Nominally 12” wide, and a rung spacing of 8 inches.

d. Channel Cable Trays: One-piece construction, nominally 4 inches wide. Slot spacing shall not exceed 4-1/2 inches o.c.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems. Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.02 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.03 EQUIPMENT FRAMES

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

1. ADC.
2. Aim Electronics; a brand of Emerson Electric Co.
3. AMP; a Tyco International Ltd. company.
4. Cooper B-Line, Inc.
5. Hubbell Premise Wiring.
6. KRONE Incorporated.
7. Leviton Voice & Data Division.
8. Middle Atlantic Products, Inc.
9. Nordex/CDT; a subsidiary of Cable Design Technologies.
10. Ortronics, Inc.
11. Panduit Corp.
12. Siemon Co. (The).

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

D. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.

6. Grounding bus bar.
7. Rack-mounted, 550-cfm fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

E. Modular Wall Cabinets:
1. Wall mounting.
2. Steel construction.
3. Treated to resist corrosion.
4. Lockable front doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Rack-mounted, 250-cfm fan.
9. Power strip.
10. All cabinets keyed alike.

F. Cable Management for Equipment Frames:
1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.04 POWER STRIPS

A. Power Strips: Comply with UL 1363.
1. Rack mounting.
2. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Cord connected with 15-foot line cord.
8. Rocker-type on-off switch, illuminated when in on position.
9. Peak Single-Impulse Surge Current Rating: 13 kA per phase.
10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330V.

2.05 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.06 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Install [underground] [buried] [aerial] pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

3.02 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.03 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping. "Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.04 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.05 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems". Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section.Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for [Class 2] [Class 3] [Class 4] level of administration; including identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 1100

SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. **62.5/125**-micrometer, optical fiber cabling.
4. Coaxial cable.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Cabling identification products.

B. Related Sections:

1. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.04 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.05 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.06 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:
    a. Nominal OD.
    b. Minimum bending radius.
    c. Maximum pulling tension.

B. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:
    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer**,** qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawing**s** and Cabling Administration Drawings by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of **Level 2 Installer**, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: **25**or less.

2. Smoke-Developed Index: **450** or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within [**two**] <**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide [**30**] <**Insert number**> days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements [provide products by one of the following:
   a. Cable Management Solutions, Inc.
   b. Cablofil Inc.
   c. Cooper B-Line, Inc.
   d. Cope - Tyco/Allied Tube & Conduit.
   e. GS Metals Corp.

2. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches (0.012 mm) thick
   a. Basket Cable Trays: 18 inches wide and 2 inches.
   b. Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high, and 2-1/2 inches deep.

2.02 BACKBOARDS

A. Backboards: Plywood, **fire-retardant treated,** 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.03 UTP CABLE

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

2. Belden CDT Inc.; Electronics Division.
3. Berk-Tek; a Nexans company.

4. CommScope, Inc.
5. Draka USA.
6. Genesis Cable Products; Honeywell International, Inc.
7. KRONE Incorporated.
8. Mohawk; a division of Belden CDT.
9. Nordex/CDT; a subsidiary of Cable Design Technologies.
10. Superior Essex Inc.
11. SYSTIMAX Solutions; a CommScope Inc. brand.
12. 3M.
13. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
a. Communications, General Purpose: Type CM or CMG[; or MPP, CMP, MPR, CMR, MP, or MPG].
b. Communications, Plenum Rated: Type CMP[or MPP], complying with NFPA 262.
c. Communications, Riser Rated: Type CMR[; or MPP, CMP, or MPR], complying with UL 1666.
d. Communications, Limited Purpose: Type CMX[; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG].
e. Multipurpose: Type MP or MPG[; or MPP or MPR].
f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR[or MPP], complying with UL 1666.

2.04 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.

9. Siemon Co. (The).
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: **One** for each conductor in assigned cables.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Factory-made, 4-pair cables in 36-inch lengths; terminated with 8-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.05 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. General Cable Technologies Corporation.
5. Mohawk; a division of Belden CDT.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 62.5/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with [TIA/EIA-492AAAA-B] [TIA/EIA-492AAAA-A] for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
a. General Purpose, Nonconductive: Type OFN or OFNG[, or OFNR, OFNP].
b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

c. Riser Rated, Nonconductive: Type OFNR[or OFNP], complying with UL 1666.

d. General Purpose, Conductive: Type OFC or OFCG[; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP].

e. Plenum Rated, Conductive: Type OFCP[or OFNP], complying with NFPA 262.

f. Riser Rated, Conductive: Type OFCR[; or OFNR, OFCP, or OFNP], complying with UL 1666.

5. Conductive cable shall be steel or aluminum armored type.

6. Maximum Attenuation: **3.50** dB/km at 850 nm; **1.5** dB/km at 1300 nm.

7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.06 OPTICAL FIBER CABLE HARDWARE

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

1. ADC.

2. American Technology Systems Industries, Inc.

3. Berk-Tek; a Nexans company.

4. Corning Cable Systems.

5. Dynacom Corporation.

6. Hubbell Premise Wiring.

7. Molex Premise Networks; a division of Molex, Inc.

8. Nordex/CDT; a subsidiary of Cable Design Technologies.

9. Optical Connectivity Solutions Division; Emerson Network Power.

10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

2. Quick-connect, simplex and duplex, [Type SC] [Type ST] [Type LC] [Type MT-RJ] connectors. Insertion loss not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.07 COAXIAL CABLE

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

1. Alpha Wire Company.
2. Belden CDT Inc.; Electronics Division.
3. Coleman Cable, Inc..
4. CommScope, Inc.
5. Draka USA.

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-11/U: NFPA 70, Type CATV.

1. No. **14** AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.

D. RG59/U: NFPA 70, Type CATVR.

1. No. **20**AWG, solid, silver-plated, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
4. Color-coded PVC jacket.

E. RG-6/U: NFPA 70, Type CATV or CM.

1. No. **16** AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

F. RG59/U: NFPA 70, Type CATV.

1. No. **20** AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
3. PVC jacket.

G. RG59/U (Plenum Rated): NFPA 70, Type CMP.

1. No. **20** AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
3. Copolymer jacket.

H. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV or CATVR.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Limited Rating: Type CATVX.

2.08 COAXIAL CABLE HARDWARE"

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

1. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division.
3. Siemon Co. (The).

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.09 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

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

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits **3 inches** above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.04 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than **60 inches (1524 mm)** apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable **6 feet (1800 mm)** long not less than **12 inches (300 mm)** in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.05 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.06 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect

grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.07 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: **2**.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section.Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for **Class 2** level of administration including optional identification requirements of this standard.

D. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables**,** terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting

hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.08 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration..

4. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 27 1300

SECTION 27 1500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 WORK INCLUDES

Provide all labor, materials, and equipment for the complete installation of all Copper Horizontal Cabling applications called for in the Bid Documents.

1.02 SCOPE OF WORK

A. This section includes the minimum requirements for Copper Horizontal Cables.

B. Horizontal (to desktop) cable shall consist of Category 6 or 6A copper cable for all Data and Voice applications.

C. At corporate, engineering and campus facilities, horizontal cabling to typical work area outlets (including offices, cubicles and conference rooms) shall consist of four Category or Category 6 cables serving each outlet. At field sales offices, horizontal cabling to typical work area outlets shall consist of two Category 5e or Category 6 cables serving each outlet.

D. Outlets for wall-mounted or other "telephone only" installations shall consist of one Category 6 cable as a minimum.

E. Outlets for wireless access points (APs) shall consist of two Category 6 cables as a minimum.

1.03 QUALITY ASSUANCE

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

B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.

C. Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:

ANSI/TIA – 568 Series Commercial Building Telecommunications Cabling Standard,

TIA – 569 Commercial Building Standard for Telecommunications Pathways and Spaces,

ANSI/TIA – 606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

ANSI-J-STD – 607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

NFPA 70 – National Electric Code

BICSI – Telecommunications Distribution Methods Manual

TIA/EIA-568-C.1 – Commercial Building Telecommunications Cabling Standard

TIA/EIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards

ISO/IEC 11801 - Generic Cabling for Customer Premises

CENELEC EN-50173 - Generic Cabling Systems

1.04 CABLE DEFINITIONS (by Type):

A. Listed CMR cable: Solid copper conductors with high-density polyolefin insulation and an overall low smoke polyvinyl chloride (PVC) jacket to achieve a riser (i.e., non-plenum) rating by applicable NEC requirements.

B. Listed CMP cable: Solid copper conductors with fluorinated ethylene propylene (FEP) insulation and an overall low smoke PVC jacket to achieve plenum rating by applicable NEC requirements.

C. LSZH cable: Solid copper conductors with non-halogen high-density polyethylene (HDPE) insulation and a low smoke, zero halogen, compound jacket to achieve a LSZH rating by applicable IEC standards

D. LC cable: Solid copper conductors with FEP fluoropolymer insulation and overall FEP fluoropolymer jacket to achieve CMP 50 rating by UL standards

E. OSP outdoor cable rated for wet locations: Solid copper conductors with polyethylene insulation, polyolefin fluted center member with flooding compound, and black polyethylene jacket

F. Comply with following general physical specifications:

1. Maximum pulling tension: 110 Newton's (25 pound-force)
2. Operating temperature: –20 to 60 degrees C [–4 to 140 degrees F]

1.05 SUBMITTALS

A. Provide product data for the following:

Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

1.06 COORDINATION

Coordinate layout and installation of cable tray with other trades.

PART 2 - PRODUCTS

2.01 DATA COMMUNICATIONS HORIZONTAL CABLING (Category 6/ClassE)

A. Category 6/Class E Unshielded Twisted-Pair (UTP) Cable

1. All Cables shall be of round construction
2. Each cable shall contain 4 color coded pairs
3. Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.)
4. Approved Manufacturer:
   a. CommScope SYSTIMAX

1071 4 pair (700211931) Riser Cat 6
2071 4 pair (700214372) Plenum Cat 6
3071 4 pair (760095554) LSZH Cat 6

   b. CommScope Uniprise

65N4 4 pair Media 6® 65N4+ Cat 6 U/UTP Cable, non-plenum
75N4 4 pair UltraMedia® 75N4 Cat 6e U/UTP Cable, non-plenum
6504 4 pair Media 6® 6504+ Cat 6 U/UTP Cable, plenum
7504 4 pair UltraMedia® 7504 Cat 6e U/UTP Cable, plenum
65N4ZH-I 4 pair Media 6® 65N4ZH-i Cat 6 U/UTP Cable, LSZH

B. Category 6 horizontal cabling shall provide the following Margin to the specification when installed in a 4 connector Channel:

Electrical Parameter (1-250MHZ)	Guaranteed Margins to Category 6 Class E Channel Specifications
Insertion loss	5%
NEXT	6 dB
PSNEXT	7.5 dB
ELFEXT	6 dB
PSELFEXT	8 dB
Rerturn Loss	4 dB

C. Category 6 horizontal cabling shall meet or exceed the performance specifications listed in the following table when installed in a 4 connector Channel.

Guaranteed Channel Performance Specifications for 4-Connection GigaSPEED XL7 U/UTP Systems										
Freq (MHz)	Insertion Loss (dB)	NEXT (dB)	ACR (dB)	PSNEXT (dB)	PSACR (dB)	ELFEXT (dB)	PSELFEXT (dB)	Return Loss (dB)	Delay (ns)	Delay Skew (ns)
1.0	2.0	71.0	69.0	69.5	67.5	69.3	68.3	23.0	580	30
4.0	3.8	69.0	65.2	68.0	64.2	57.2	56.2	23.0	562	30
8.0	5.4	64.2	58.8	63.1	57.7	51.2	50.2	23.0	557	30
10.0	6.0	62.6	56.6	61.5	55.5	49.3	48.3	23.0	555	30
16.0	7.6	59.2	51.6	58.1	50.4	45.2	44.2	22.0	553	30
20.0	8.6	57.6	49.1	56.5	47.9	43.2	42.2	21.5	552	30

25.0	9.6	56.0	46.4	54.8	45.2	41.3	40.3	21.0	551	30
31.25	10.8	54.4	43.6	53.2	42.4	39.4	38.4	20.5	550	30
62.5	15.6	49.4	33.7	48.1	32.4	33.3	32.3	18.0	549	30
100.0	20.2	45.9	25.7	44.6	24.3	29.3	28.3	16.0	548	30
200.0	30.0	40.8	10.8	39.4	9.4	23.2	22.2	13.0	547	30
250.0	34.1	39.1	5.0	37.7	3.5	21.3	20.3	12.0	546	30

1. The table provides reference values only. All parameters comply with the governing equations over the entire frequency range.
2. All values and equations apply to worst-case channels utilizing four-pair 71E series cables with full cross-connects, consolidation points and work area outlets (4 connectors in a channel) for any channel lengths up to 100 meters.

D. Category 6 horizontal cabling shall provide the following Margin to the specification when installed in a 6 connector Channel

Electrical Parameter (1-250MHZ)	Guaranteed Margins to Category 6 Class E Channel Specifications
Insertion loss	4%
NEXT	4 dB
PSNEXT	5.5 dB
ELFEXT	4 dB
PSELFEXT	6 dB
Rerturn Loss	2 dB

E. Category 6 horizontal cabling shall meet or exceed the performance specifications listed in the following table when installed in a 6 connector Channel.

Guaranteed Channel Performance Specifications for 6-Connection GigaSPEED XL7 U/UTP Systems										
Freq (MHz)	Insertion Loss (dB)	NEXT (dB)	ACR (dB)	PSNEXT (dB)	PSACR (dB)	ELFEXT (dB)]	PSELFEXT (dB)	Return Loss (dB)	Delay (ns)	Delay Skew (ns)
1.0	2.1	69.0	66.9	67.5	65.4	67.3	66.3	21.0	580	30
4.0	3.9	67.0	63.2	66.0	62.1	55.2	54.2	21.0	562	30
8.0	5.4	62.2	56.7	61.1	55.7	49.2	48.2	21.0	557	30
10.0	6.1	60.6	54.5	59.5	53.4	47.3	46.3	21.0	555	30
16.0	7.7	57.2	49.5	56.1	48.4	43.2	42.2	20.0	553	30
20.0	8.7	55.6	47.0	54.4	45.8	41.2	40.2	19.5	552	30
25.0	9.7	54.0	44.3	52.8	43.1	39.3	38.3	19.0	551	30
31.25	10.9	52.4	41.5	51.2	40.3	37.4	36.4	18.5	550	30
62.5	15.8	47.4	31.6	46.1	30.3	31.3	30.3	16.0	549	30
100.0	20.4	43.9	23.5	42.6	22.1	27.3	26.3	14.0	548	30
200.0	30.3	38.8	8.5	37.4	7.1	21.2	20.2	11.0	547	30
250.0	34.5	37.1	2.6	35.7	1.2	19.3	18.3	10.0	546	30

1. The table provides reference values only. All parameters comply with the governing equations over the entire frequency range.
2. All values and equations apply to worst-case channels utilizing four-pair 71E series cables with up to 6 embedded connections in a channel for any channel lengths up to 100 meters.

2.04 DATA COMMUNICATIONS HORIZONTAL CABLING (Category 6A/Class EA)

A. Category 6 Augmented (6A)/Class EA Unshielded Twisted-Pair (UTP) Cable

1. All Cables shall be of round construction
2. Each cable shall contain 4 color coded pairs
3. Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.)
4. Approved Manufacturer:
   a. CommScope SYSTIMAX

1091B 4 pair (760107078) Riser Cat 6A

2091B 4 pair (760107250) Plenum Cat 6A

3091B 4 pair (760107334) LSZH Cat 6A

1088B 4 pair (760142547) Riser EXPRESS Cat 6A

2088B 4 pair (760142638) Plenum EXPRESS Cat 6A

3088B 4 pair (760142679) LSZH EXPRESS Cat 6A

   a. CommScope Uniprise

10GN4 4 pair Ultra 10® 10GN4 Cat 6A U/UTP Cable, non-plenum

10G4 4 pair Ultra 10® 10GN4 Cat 6A U/UTP Cable, non-plenum

B. Category 6A horizontal cabling shall provide the following Margin to the specification when installed in a 4 connector Channel.

Electrical Parameter (1-250MHZ)	Guaranteed Channel Margins to Amendment 1 to ISO/IEC 11801:2002 "Class E_A"
Insertion loss	3%
NEXT	3 dB
PSNEXT	5 dB
ACR-N	5 dB
PSACR-N	6.5 dB
ACR-F	6 dB
PSACR-F	8 dB
Return Loss	1 dB
Rerturn Loss, PSANEXT, PSAACR-F, Avg. PSANEXT, Avg. PSAACR-F	2 dB

C. Category 6A horizontal cabling shall meet or exceed the performance specifications listed in the following table when installed in a 4 connector Channel.

Guaranteed Channel Performance Specifications for 4-Connection GigaSPEED 360X10D U/UTP Systems														
Freq (MHz)	Insertion Loss (dB)	PS ANEXT (dB)	Avg. PS ANEXT (dB)	PS AACR-F (dB)	AVG. PS AACR-F (dB)	NEXT (dB)	ACR-N (dB)	PS NEXT (dB)	PS ACR-N (dB)	ACR-F (dB)	PS ACR-F (dB)	Return Loss (dB)	Delay (ns)	Delay Skew (ns)
1	2.2	82.0	84.3	79.0	83.0	75.7	73.5	75.3	73.1	69.3	68.3	20.0	580	40
4	4.0	76.0	78.2	67.0	71.0	66.0	62.0	65.5	61.5	57.2	56.2	20.0	562	40
8	5.6	73.0	75.2	60.9	64.9	61.2	55.5	60.6	55.0	51.2	50.2	20.0	557	40
10	6.3	72.0	74.3	59.0	63.0	59.6	53.3	59.0	52.7	49.3	48.3	20.0	555	40
16	7.9	70.0	72.2	54.9	58.9	56.2	48.3	55.6	47.7	45.2	44.2	19.0	553	40
20	8.9	69.0	71.2	53.0	57.0	54.6	45.7	54.0	45.1	43.2	42.2	18.5	552	40
25	9.9	68.0	70.3	51.0	55.0	53.0	43.1	52.3	42.4	41.3	40.3	18.0	551	40
31.3	11.1	67.0	69.3	49.1	53.1	51.4	40.3	50.7	39.6	39.3	38.3	17.5	550	40
62.5	15.9	64.0	66.3	43.1	47.1	46.4	30.5	45.6	29.7	33.3	32.3	15.0	549	40
100	20.3	62.0	64.3	39.0	43.0	42.9	22.7	42.1	21.8	29.3	28.3	13.0	548	40
200	29.2	57.5	59.7	33.0	37.0	37.8	8.6	36.9	7.7	23.2	22.2	10.0	547	40
250	32.9	56.0	58.3	31.0	35.0	36.1	3.2	35.2	2.3	21.3	20.3	9.0	546	40
300	36.2	54.8	57.1	29.5	33.5	34.7	-1.5	33.8	-2.5	19.7	18.7	8.2	546	40
400	42.3	53.0	55.2	27.0	31.0	32.6	-9.8	31.6	-10.8	17.2	16.2	7.0	546	40
500	47.8	51.5	53.8	25.0	29.0	30.9	-17.0	29.8	-18.0	15.3	14.3	7.0	546	40

1. The table provides reference values only. All parameters comply with the governing equations over the entire frequency range.
2. All values and equations apply to worst-case channels utilizing four-pair 91A series cables with full cross-connects, consolidation points and work area outlets (4 connections in a channel) for the length up to 100 meters.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.

B. Cable shall be installed following industry standard practices.

C. Horizontal cabling shall be installed from the work area outlet location to the nearest Telecommunications Space.

D. Horizontal cabling shall be terminated on a patch panel in the telecommunication space which is the same category rating as the Cable. i.e. Cat 6 cable terminates on Cat 6 panels.

E. Contractor shall not exceed the maximum pulling tension or the minimum bending radius for twisted pair cables per manufacturer's specifications.

F. Contractor shall test all horizontal links per the ANSI/TIA-568 Requirements.

END OF SECTION 27 1500

SECTION 28 1300 - ACCESS CONTROL

PART 1 - GENERAL

1.01 SUMMARY

1. The access control system and security management system shall be deployed through IP network infrastructure with a two- tiered hardware hierarchy. The IP Door Controller shall be capable of running on a TCP/IP network and shall be accessible, configurable, and manageable from a network-connected PC with a browser.
2. Browser access for configuration and administration of the system shall be possible from a PC on the same subnet, through routers and gateways from other subnets, and from the Internet.
3. The top hardware tier shall be the MonitorCast v4 Server based platform. Installed applications on the MonitorCast v4 Server is to be an operating system, a web MonitorCast v4 Server, security application software, and the database of personnel and system activity.
4. The bottom hardware tier shall be the IP Door Controller. The IP Door Controller shall make and manage access control decisions with data provided by the MonitorCast v4 Server, and it shall control the communication between the IP Door Controller and door hardware connected to the IP Door Controller inputs, outputs, and readers. This modular design shall make it possible for the system to continue to manage access control and store system activity logs, even during network downtime. When network connectivity is re-established, the system activity logs shall be automatically re- integrated to the host MonitorCast v4 server.
5. The system shall integrate, within a browser interface; access control and video monitoring. These applications shall be a fully bi-directional integrated software architecture.
    a) The database tier shall use Microsoft SQL Server residing on the MonitorCast v4 Server. Microsoft SQL Server on the MonitorCast v4 Server shall be a full featured, high performance database management system. This shall provide a small footprint, low administration, and a high reliability relational database that is embedded without requiring the use of a separate PC MonitorCast v4 Server.
    b) The MonitorCast v4 Server tier shall be based on a Microsoft™ MonitorCast v4 Server 2008 R2 or 2012 MonitorCast v4 Server. This application shall provide a graphically rich security management application through a standard web browser.
6. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer’s system.
7. All systems and components shall have been thoroughly tested and proven in actual use.
8. All systems and components shall be provided with a manufacturer warranty of one year for software and two years for hardware.

1.02 OVERALL SYSTEM CAPABILITY

1. The security management system shall meet the requirements of business and government access control systems. The system shall monitor and control facility access and shall perform alarm monitoring and integration to camera and video monitoring. The system shall also maintain a database of system activity, personnel access control information, and system user passwords and user role permissions. The system shall be controlled from a web browser and require no software installation or client licenses. The system shall provide control and access to users on Local Area Networks (LAN), Wide Area Networks, wireless networks, and the Internet. The

system shall provide email and/or text message alerts for all alarm conditions and threats.

2. System Partitioning: The system administrator shall have the ability to divide the system into partitions, allowing subsets of the overall population and/or resources to be managed separately.
   a) From the default Master partition, one or more additional partitions shall be able to be created.
   b) Each partition shall contain some number of administrators, card holders with their credentials, and resources.
   c) When performing administrative functions, the administrator of a partition shall have the ability to create or modify only the cardholders and resources in that partition. However, resources shall be able to be shared across partitions through the mapping of access levels from one partition to another.
   d) System partitioning shall have a precision feature that allows administrators in one or more partitions to view and perform edit functions on person records that belong to another partition.
   e) Administrators shall have the ability to search for person records across all partitions to which they have access. The system administrator shall have the ability to make such cross- partition searches the default for users who have access to multiple partitions.
   f) After finding a personnel group record located in another partition, an administrator shall be able to click a button to switch to that partition directly from the personnel group record—and possibly edit the record, depending on his or her access rights in that partition. Alternatively, an option for making every person record seamlessly visible across all partitions shall be provided.
3. The system shall provide the following Access Control capabilities:
   a) Integrated photo ID creation capability with video verification.
   b) User interface secured access under encrypted password control.
   c) Multiple Site Control.
   d) System-wide timed anti-pass back function.
   e) “First-in-unlock” rule enforcement.
   f) Multiple access levels and cards per person.
   g) Detailed time specifications.
   h) Simultaneous support for multiple card data formats.
   i) Compatibility with various input devices, including biometric readers.
   j) Activation/expiration date/time by person with one-minute resolution.
   k) Access level disable for immediate lockdown.
   l) Multiple holiday schedules.
   m) Timed unlock schedules.
   n) Dual-reader portal support.
   o) Wiegand Reader support.
   p) Magnetic-stripe reader support.
   q) Wiegand keypad PIN support for 4-digit or 6-digit PINs.
4. The system shall provide the following native or VMS integrated monitoring capabilities:
   a) The Home page shall allow users to view a full system summary, including an Activity Log, Auto- Monitor, and dashboard functions.
   b) Common alarm panel integration for disarm on access, and arm on egress.
   c) Integrated real-time IP-based NVR systems with stored video replay for events.
   d) Provides alarms on communication loss.
   e) Provides the ability to record video and link to video for alarm events.

f) A monitoring desktop that integrates video, system activity logs, floorplans, ID photos, and alarm notifications.
g) Graphic floorplans with active icons of monitor and access control points.
h) Secure access to the user interface under encrypted password control.
i) Delivery of alerts via VMS Rules Manager or Automation and email.
j) Remote logging of system messages to local host.

5. The system shall provide the following integrated VMS Video Management capabilities:
   a) Playback of event-related video.
   b) Integrated alarm inputs from the video management system.
   c) Digital playback of video events.
   d) Linking of video and events based on triggers provided by the system or video system.
   e) Support for multiple NVRs.
   f) Multiple pre-programmed supported cameras.
   g) Monitoring and control through a web browser interface.
6. The system shall provide the following Security Database capabilities:
   a) Maintain data of system activity, personnel access control information, system user passwords and custom user role permissions for whole or partial access to system resources and data.
   b) LDAP integration for single-user logon authentication.
   c) Network-secure API for external application integration.
   d) Easy to use custom report generator.
   e) Record recall by vehicle tag, name, or card.
   f) An API for adding to, deleting from, and modifying the database.
   g) Storage of system user passwords and permissions.
   h) Storage and recall of ID photos and emergency personal information.
   i) Pre-defined reports on system configuration, system activity history, and people.
   j) Custom report writer interface that allows the interactive creation of custom reports. Reports may be saved for later reuse. No third-party software (such as Crystal Reports) shall be necessary.
   k) Selectable custom report output formats, including PDF & CSV.
   l) Custom report repository location. Users shall be able to review, cancel and delete reports from this data storage location.
   m) Email and text messaging (SMS) alert notifications.

1.03 HARDWARE REQUIREMENTS

1. The security management system shall employ a modular hardware concept that enables simple system expansion and utilizes a two-tiered hardware hierarchy:
   a) At the top tier shall be a MonitorCast v4 Server, which shall contain the database engine, web MonitorCast v4 Server, application software, and configuration data. It is at this level that System Users, through a browser interface, shall interact with the system, set configurations, monitor activities, run reports, and manage alarms.
   b) At the bottom tier shall be the IP Door Controller, an intelligent device with native TCP/IP & PoE support, which shall make and manage access control decisions, a set of inputs, outputs and readers.
   c) The network device shall run on existing building TCP/IP PoE networks and shall be configurable for access from separate subnets, through gateways and routers, and from the Internet.
2. A MonitorCast v4 Server shall contain a processor, flash memory, and storage. External battery backup shall be used to provide uninterrupted operation in the event of external power

loss. The IP Door Controller shall contain IIS for communication with the IP Door Controllers and a network interface port. A MonitorCast v4 Server shall have the following capabilities:

a. Door Controller: (Mercury EP/LP boards) (AD-400/AD-300 Wireless locks) 512
b. Access cards: No Limit
c. Card formats: 15 per Controller
d. Alarm input points: 2,048 per Controller
e. Control point outputs: 2,048 per Controller
f. Ethernet ports: 1
g. Time specifications 512 per Controller
h. Holidays 255 per Controller
i. Access levels per person 15 per person (32,000 per Controller)
j. Cards per person No Limit
k. Concurrent system users Unlimited

3. The IP Door Controller shall make and manage access control decisions with data provided by the MonitorCast v4 Server, and it shall manage the communication between the IP Door Controller connected to the system's inputs, outputs, and readers. The IP Door Controller shall be powered with PoE power input 12.95 W (802.3af or 12V DC 900mA power supply) protocol. Each IP Door Controller shall have the following capabilities:
    1. Access control doors 1
    2. Readers 2
    3. Supervised Inputs 2
    4. General Input 2
    5. Relay Outputs 2
    6. Connectivity 10/100 Ethernet
    7. Credential storage 20,000
    8. Activity Log records 27,000
4. The IP Door Sub-Controller single door shall make and manage access control decisions with data provided by the MonitorCast v4 Server through the IP Door Sub-Controller, and it shall manage the communication between the IP Door Sub-Controller connected to the system's inputs, outputs, and readers. The IP Door Controller shall be powered with PoE power input 12.95 W (802.3af or 12V DC 900mA power supply) protocol. Each IP Door Controller shall have the following capabilities:
    1. Access control doors 1
    2. Readers 1
    3. Supervised Input 4
    4. Relay Outputs 2
    5. Connectivity 10/100 Ethernet
5. The Door Sub-Controller single door shall make and manage access control decisions with data provided by the MonitorCast v4 Server through the IP Door Controller, and it shall manage the communication between the IP Door Sub-Controller connected to the system's inputs, outputs, and readers. The IP Door Sub- Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Door Sub-Controller shall have the following capabilities:

a. Access control doors 1
b. Readers 1
c. General Input 2 (programmable)
d. Dedicated Input 1
e. Relay Outputs 2
f. Connectivity RS-485

6. The Door Sub-Controller two door shall make and manage access control decisions with data provided by the MonitorCast v4 Server through the IP Door Controller, and it shall manage the communication between the IP Door Sub-Controller connected to the system's inputs, outputs and readers. The IP Door Sub-Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Door Sub-Controller shall have the following capabilities:
   a. Access control doors 2
   b. Readers 1
   c. General Input 8 (programmable)
   d. Dedicated Input 2
   e. Relay Outputs 6
   f. Connectivity RS-485
7. The Serial Input Sub-Controller shall make and manage access control decisions with data provided by the MonitorCast v4 Server through the IP Door Controller, and it shall manage the communication between the IP Serial Input Sub-Controller connected to the system's inputs and outputs. The IP Serial Input Sub- Controller shall be connected to IP Door Controller using RS-485 protocol. Each IP Serial Input Sub- Controller shall have the following capabilities:
   a. General Input 16 (programmable)
   b. Dedicated Input 2
   c. Relay Outputs 2
   d. Connectivity RS-485
8. The Serial Output Sub-Controller shall make and manage access control decisions with data provided by the MonitorCast v4 Server through the IP Door Controller, and it shall manage the communication between the IP Serial Output Sub-Controller connected to the system's inputs & outputs. The IP Serial Output Sub- Controller shall be connected to IP Door Controller using RS- 485 protocol. Each IP Serial Output Sub- Controller shall have the following capabilities:
   a. General Output 16
   b. Dedicated Inputs 2
   c. Connectivity RS-485

1.04 HARDWARE PACKAGING REQUIREMENTS

2. The security management system shall have various hardware enclosures and configurations available to support different installation requirements. Enclosures shall be available for wall or rack mounting. The wall- mount enclosures shall have a lock requiring a key.

1.05 CERTIFICATIONS

1. UL 294 listed.
2. ISO 9000 listed.
3. CE Compliant.
4. RoHS.

PART 2 PRODUCT

2.01 MONITORCAST v4 ACCESS CONTROL SOFTWARE

A. Operating System and Application Software shall have the following characteristics:

1. The MonitorCast v4 Server operating system shall Windows Server 2008 R2 or Windows Server 2012 operating system.
2. The system database shall be SQL Server Express requiring a small footprint and providing high reliability. The MonitorCast v4 Server shall provide users with access and operate the system using a standard web browser.
3. The system shall support the following web browsers:
    a. For the security management system, the listed browsers shall include Internet Explorer, Firefox, Chrome and Safari.

B. Software Licensing shall have the following characteristics:
1. Software licensing shall be based upon the number of cameras licenses you have per server and individual lifetime licensing in situations where doors out number cameras at the project site.
2. Licensing shall be controlled by a Serial Key and an Activation Code. The Serial Key shall contain the licensed system limits. System upgrade licensing to enable more cameras or more doors shall require a Serial Key re-activation. The key shall be locked to the system license number.

C. Software upgrades shall be possible from a browser on any network-connected PC, by uploading a software update to the IP Door Controller. No client software installation shall be necessary.

D. Online Help and Documentation - The system shall be provided with complete online documentation. The online documentation shall include:
1. Technical Support Notes - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
2. Installation Guides - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
3. Video Integration Guides - These documents shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.
4. End-User Task Guide - This document shall be in PDF format, shall be printable, and shall be linked to from the Help system table of contents, index, and related topics.

E. Language Support - The system shall be provided with multiple language support. The ability to switch from one language to another shall be accomplished through the user interface. Translation of the user interface, online help and documentation into other languages shall be available. The languages supported shall include:
1. English

F. Date Formats - The system shall support global date formats as follows:
1. mm/dd/yyyy
2. dd/mm/yyyy
3. yyyy/mm/dd

G. Floor plans - The system shall provide graphic floorplan capability including graphic display of door status and entry direction. Floor plans shall have the following characteristics:
1. The Network Administrator shall be able to graphically configure device icons onto the floorplan images, and to upload additional floorplan images. JPEG images shall be supported, and the maximum size for a floorplan image shall be 256K.

H. Personnel Data - The system shall maintain person data relating to access control, system user privileges, photo identification, system activity, and contact information.
1. All person data in the system shall be integrated onto one page for viewing, editing, and deletion by system users.
2. A system user holding at least an “Administrator” user role shall be able to create, delete, and modify person records, including access levels, schedules & resource groups.
3. A system user holding at least a “Administrator” user role shall be able to configure the display of person records.

I. Access Control:
   1. The system shall be able to make access control decisions, define a variety of access levels and time specifications, write system activity into a log file, maintain a personnel enrollment database, receive signals from input devices such as door switch monitors, card readers and motion detectors, energize devices such as door locks and alarms via outputs.
   2. Card Formats - The system shall support the use of readers that use the Wiegand Reader Interface. The system shall also support the use of the Magnetic Stripe ABA track 2 card data formats.
      a. It shall be possible to create new card formats, designate start bits and bit lengths for facility codes and card ID numbers, as well as designate parity bits. The system shall support up to 32 different card formats.
   3. Access Levels - The system shall be capable of storing unlimited access levels in each partition.
      a. The definition of an access level shall require the assignment of a reader or reader group, and a time specification.
   4. First-in Unlock Rule - The system shall support the use of a First-in unlock rule. It shall be possible to use this rule to control the unlock behavior of portal groups with assigned unlock time specs.
      a. The First-in unlock rule shall require a card read of a specified access level. The portals in the group shall unlock only when the rule is satisfied and the unlock time spec is valid.
   5. Holidays - The system shall be capable of storing up to 5 holidays per system. Each holiday shall be assigned a unique alphanumeric name. The definition of a holiday shall require a start date and an end date. Holidays shall have the ability to span several days using only one holiday slot. Holiday definitions shall support the designation of a start time and an end time. If no start time is designated, then the system shall default to 00:00 (start-of-day). If no end time is designated, then the system shall default to 24:00 (end-of-day). Holidays shall require the use of 24-hour time format, e.g. 17:00 is 5:00PM.

J. Reports:
   1. The system shall be capable of producing a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.
   2. The system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters shall be inserted into reports to prompt for data input at report runtime. Report results shall be printed, output to a PDF file or put into a spreadsheet.
   3. The system shall be capable of sorting users by various criteria, including email address, and allow for email groups to be selected for auto-distribution.
   4. Report generation shall not affect the real-time operation of the system.
   5. The specific reports provided shall include the following:
      a. Configuration Reports
         i. Access History - Displays access history based on an entered query. The system user can specify the query using either the keyboard or point-and-click selection.
         ii. Custom Report - This provides the capability to create custom reports of historical data.
         iii. General Event History - Displays time, type of activity, and activity details for a variety of event types. The system user can select the specific event types for the report.

iv. Audit Trail: Displays an audit trail of system changes and the name of the system user that made the changes. It shall be possible to specify the dates and times covered in the report.

b. People Reports
   i. Access Levels - Displays all access levels entered into the system including time specification, reader/reader group, and floor group.
   ii. Credential Audit - Lists existing credentials by their current status settings (such as Active, Damaged, Lost, or Not Used). Before running the report, users can filter the data to see only credentials with a particular status setting, or only credentials that were not used with a specific number of days from the date they were issued.
   iii. Current Users - Displays a list of all security system users currently logged in to the security system website.
   iv. Custom Report - This provides the capability to create custom reports of personnel data. A graphic interface provides the user with the ability to interactively create and save reports for later use. Parameters can be inserted into reports to prompt for data input at report runtime. Custom report configuration shall include page size, orientation, column width and shall automatically notify the user if the selected configuration exceeds the selected page size.

K. Administration - The system shall provide for the performance of system administration tasks from any network-connected computer with a browser. These administrative tasks shall include but not be limited to:

1. Generating reports:
   a. The system shall be capable of producing a variety of predefined reports regarding software and security hardware configuration, event history, and the administration of people within the system.
   b. Alternatively, the system shall support a graphic interface for interactively building custom reports from either historical or personnel data. These reports shall be savable for later reuse. Parameters can be inserted into reports to prompt for data input at report runtime. Report results can be printed, output to a PDF file or put into a spreadsheet.
   c. A system user holding “Administrator” permissions shall be able to view and create reports.
2. Database backups:
   a. It shall also be possible for the system users to create such database backups at any time. Any database backups onboard the MonitorCast v4 Server may also be downloaded to IP Door Controller storage by the system user at any time.
3. System restore:
   a. The system shall be able to restore its database, or the full system data, from a backup. Restoration of the system shall only be possible from a backup copy onboard the MonitorCast v4 Server. It shall, therefore, be possible to upload a copy of a database backup from any network attached storage.
4. Software updates:
   a. Software updates, upgrades and patches shall be provided from time to time. The system shall be able to update its software from these files. Update of the application software shall only be possible from an update file onboard the Server. It shall, therefore, be possible to upload a copy of the software update from any network attached storage or from any PC drive or desktop.

b. Software updates may involve the Server only or may include updates for the IP Door Controller also. The monitoring of the security system may be unavailable for several minutes during this process.

5. Enrolling new people - All person data entered into the system shall be held in the system database and shall be available only to system users holding at least the Administer user role. Person data can be added, deleted, and edited by such system users.
6. Configuring network resources:
    a. DNS - The system shall support setting IP addresses for up to two domain name MonitorCast v4 Servers.
    b. Email settings - The system shall support the use of email notifications of alarm events. The system user must setup the email MonitorCast v4 Server IP address or DNS name and the email address of the Network Controller. A network administrator must setup the network mail MonitorCast v4 Server to relay email for the IP address of the Network Controller.
    c. Time MonitorCast v4 Servers - The system shall support the use of network time MonitorCast v4 Servers. Up to three MonitorCast v4 Servers can be designated. Use of a network time MonitorCast v4 Server ensures that the Network Controller and its nodes will be regularly synchronized with the exact time used by all other network resources.
    d. A system user holding “Setup” permissions shall be able to configure network resources.
7. LDAP - It shall be possible to configure an Active Directory MonitorCast v4 Server with the system.
    a. This shall provide single user-login capability.
    b. Password rules and authentication shall be governed by the LDAP MonitorCast v4 Server.

2.02 MONITORCAST SERVER HARDWARE AND DOOR CONTROLLERS

A. The MonitorCast v4 Server shall be powered by platinum efficiency hot plug redundant 495 W or 750 W power supply.
1. OS Windows Server 2008 R2/2012
2. Storage 200 GB (minimum)
3. Processor Intel I5 class processor or higher
4. RAM 8 GB
5. Ethernet Ports 1
6. Warranty 3 Years
7.

B. Each IP Door Controller shall be powered by PoE in accordance with IEEE 802.3af standard. With PoE as the power source the total power available for all external outputs is 12V DC @ 650mA. IP Door Controllers shall have the following characteristics:
1. TTL reader connectors 2
2. RS-485 reader connectors 1
3. Output power 650 milliamps
4. Input connectors 2
5. Output connections 2

C. Each IP Door Sub-Controller shall be powered by PoE in accordance with IEEE 802.3af standard. With PoE as the power source the total power available for all external 12V. IP Door Controllers shall have the following characteristics:
   1. TTL reader connectors 1
   2. Power available to readers 150 milliamps
   3. Input connectors 4
   4. Output connections 2

D. Each Single Door Sub-Controller shall be powered by may be supplied with 12-24V DC at 3 amps. With a 12V DC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:
   1. TTL reader connectors 1
   2. Power available to readers 150 milliamps
   3. Input connectors 3
   4. Output connections 2
   5. Communication protocol RS-485

E. Each Two Door Sub-Controller shall be powered by may be supplied with 12-24V DC at 3 amps. With a 12V DC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:
   1. TTL reader connectors 2
   2. Power available to readers 150 milliamps
   3. Input connectors 10
   4. Output connections 6
   5. Communication protocol RS-485

F. Each Serial Input Sub-Controller shall be powered by may be supplied with 12-24V DC at 3 amps. With a 12V DC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:
   1. General Input connectors 16
   2. Dedicated Input connectors 2
   3. Output connections 2
   4. Communication protocol RS-485

G. Each Serial Output Sub-Controller shall be powered by may be supplied with 12-24V DC at 3 amps. With a 12V DC 3A power supply the total power available for all external output shall be 1100mA (13 watts). IP Door Controllers shall have the following characteristics:
   1. General Output connectors 16
   2. Input connections 2
   3. Communication protocol RS-485

END OF SECTION 281300

SECTION 28 2313 -VIDEO SURVEILLANCE CONTROL AND MANAGEMENT SYSTEMS

PART 1 GENERAL- VIDEO MANAGEMENT SYSTEM GENERAL DESCRIPTION

A. The Video Management System shall be i-PRO VideoInsight v7.9

1.01 SUMMARY

A. The software used shall be designed for enterprise level use, with an expected use period of 24/7. It shall be the Manufacturer's official software.
B. The software shall incorporate open standards and published protocols and use standardized components.
C. The Video Management System provider shall be defined as the provider of the video management software, and the party responsible for rigorous self-testing of the video management software prior to the release of the software.

1.02 WARRANTY

A. All configurations set up, installation and integration of the software shall be done by qualified technicians who have passed a manufacturer's training program.
B. All system components shall be from or supported by the original manufacturer

PART 2 PRODUCTS

2.01 VIDEOINSIGHT SERVER SOFTWARE (IP SERVER)

1. IP Server shall be designed to run on a Windows platform, supporting both Desktop and Server class operating systems including 10 (Pro), 2008 R2, 2012, 2016 and 2019.
2. It shall run as a Window's Service. This service shall run as part of the local service account. This service shall be running as long as the system is booted and has started Windows. It shall not require the user to be logged in.
3. It shall store settings in SQL Express and shall not require a full MS-SQL license.
4. It shall have an option for a 32-bit binary and a true 64-bit binary. In a 64-bit OS, it shall run as a native 64-bit application, not merely a 32-bit application.
5. The service shall connect to the camera and handle streaming to the server. It shall not require each client to connect to individual cameras.
6. This service shall allow the cameras to be placed on one network and the clients on a separate network using a different IP range.
7. The software shall support the ONVIF standard.
8. The software shall support Megapixel virtual cameras within a single camera license.
9. IP Server shall record the video streams from different cameras.
    a. For MPEG-4 based cameras, the video shall be stored in the native codec of the server.

b. For H.264/H.265 based cameras the video shall be stored in the native codec of the server.
c. Each camera will have the option to be able to be stored in different locations
d. Streaming from server to client shall support H.264/H.265.
e. The server must have Pivot 3 integration.

10. IP Server shall support H.264/H.265, MPEG-4, MJPEG and MXPEG based cameras.
11. IP Server shall support motion detection at the camera and at the software levels.
12. IP Server shall provide graphic examples of what it determines as motion to thick clients if the thick client requests it.
    a. The software shall display the motion detection as an outline around the area moving.
    b. The software shall provide a bar showing the total percentage of change. This bar shall have a slider on it to allow the user to quickly set motion detection.
13. IP Server shall allow for multiple zones to be set within an image that support differing motion detection values within a cameras field of view.
    a. There shall be no limit on the total number of zones allowed, either on a per camera or per server basis.
    b. Zones should allow the ability to ignore motion within an area.
    c. The user shall have the ability to move the zones after the fact.
    d. Motion zones shall be able to be tied into a rules engine to allow the software to use them as triggers for events.
14. IP Server shall support the use of imported maps to show camera placement. The formats for these maps will be JPG, GIF or BMP as determined by the user.
    a. Hovering over a camera on a map shall cause it to be displayed in a window on the side.
    b. When the camera is displayed on the side, the option to review recently recorded video will be available to them.
    c. The user shall be able to embed layouts onto the facility map. Clicking on the layout shall change the display of the client software.
    d. Alarms from DIOs shall be able to be embedded as well.
    e. Audio sources shall also be an option.
    f. Other facility maps shall also be an option to embed. Clicking on a different embedded map shall bring up that map.
    g. Doors from certain access control systems can be imported and displayed. Hovering over the door shall display the last badge used to badge in, a live view of the camera associated with the door. The user from this pop up shall be able to see badge events and alarm events along with the associated video.
15. IP Server shall not require the administrator to contact the manufacturer to replace a camera.
16. IP Server shall support reporting to a diagnostic tool:
    a. Number of active cameras.
    b. Active cameras offline.
    c. Version of the server.
    d. Amount of disk space left.
    e. Recording status of the server.

17. IP Server shall support pre-motion and post motion recording.
18. IP Server shall support various layouts. The layouts will allow for blank spaces within the layout.
19. IP Server shall support an unlimited number of users:
    a. Users can be drawn from either an Active Directory server, Novell eDirectory, or entered manually.
    b. There will be two different levels of user (Administrator and User).
    c. Users can be members of a group with settings set for the group. Individual user settings can override the group settings.
    d. Permissions can be set for live viewing, access to recorded video, control of PTZ cameras, access to audio, the ability to export video, custom layouts, facility maps and rules. Permissions can be defined on a per camera basis.
    e. It shall support the option of having the users limited to being signed into a single location.
20. IP Server shall include a diagnostic version with limited interface, to allow for testing of the server.
21. It shall support an optional secondary server with failover capacity.
22. A rules engine shall be included to allow the server to handle more complex tasks.
    a. Triggers will include:
        1. Dry contacts (DIO).
        2. Motion detection of a camera stream.
        3. Video Analytics event of a camera stream
        4. Scheduled events. Events can be scheduled on daily, weekly, or monthly basis. Individual events can be handled as well.
        5. An Alert button for the user interaction in the VI Monitor.
        6. Inputs sent programmatically via appropriate APIs.
        7. Access control events from supported Access Control Vendors.
        8. LPR events.
        9. User login events.
    b. Actions will include:
        1. Logging the event.
        2. Opening or closing a dry contact.
        3. Sending an e-mail with a custom text message tied to the trigger. Multiple texts will be allowed for different triggers.
        4. Sending an e-mail with an AVI/MP4 clip from a selected camera.
        5. Sending an e-mail with a JPG file of a selected event from a camera.
        6. Opening a live window for a user who is viewing.
        7. Move a PTZ to a certain preset location.
        8. Force recording.
        9. Force recording with audio.
        10. Instant Replay.
        11. Sending video to a Network Decoder.
        12. Switching single camera or layout views.
        13. Message Instruction.

14. Moving, copying, or deleting of files.
15. Execute a program or batch file.
16. Send an ASCII string to a TCP port.
17. Change the state of the door
18. Send an HTTP command to a specific device.
19. Displays alarm window for client within Workspaces and Message Display
20. Audio alert for a specified Client.
21. Switch viewing field to a specific camera, capable of audio recording.
22. Create time-lapse recordings (very low frame rate).
23. Mask / unmask monitor points

23. IP Server shall support time out functionality.
24. The IP Server software shall support generic RTSP connections
25. PTZ functionality within the camera shall be supported.
26. Dewarping of Panoramic shall be supported for the following manufacturers:
    a. Advidia
    b. AMG
    c. Axis
    d. Oncam
    e. Pelco
    f. Panasonic i-PRO
    g. Sentry 360
    h. Uniview
    i. Vivotek
    j. Dlink
    k. Dynacolor
    l. EverForcus
    m. GridSmart
    n. IDIS
    o. ACTi
    p. GeoVision
    q. Hanwha
    r. Samsung
    s. ImmerVision
27. IP Server shall only stream video to the clients that requested them.
28. If live video is paused, then IP Server shall stop streaming video to the clients to conserve bandwidth.
29. IP Server shall support integration with various access control platforms, including:
    a. Imron
    b. MonitorCast v.3 and 4
    c. AMAG
    d. Badge Pass
    e. Blackboard
    f. Continental
    g. Infinias

h. Isonas
i. Lenel
j. Paxton
k. CCURE
l. DSX
m. Gallagher
n. Maxxess
o. RBH
p. S2
q. Open Options
r. Sureview

30. With Isonas, MonitorCast v.4 and Paxton, IP Server shall allow for importing the doors from those systems and respond to events in the VMS software along with basic door control.
31. IP Server shall have support panic button functionality through rules engine.
32. IP Server shall support integration with Panasonic i-PRO BWC MK3 and BWC4000 Body cameras. The integration must be to automatically retrieve a recorded video in BWC to IP Server.
33. IP Server shall support integration with Halo Smart Sensor which can detect Vape, Temperature and Gunshot etc. The alarm shall be used as Rule Trigger and be able to make a Rule action.
34. IP Server shall support integration with OPTEX Laser sensor which can detect Vape, Temperature and Gunshot etc. The alarm shall be used as Rule Trigger and be able to make a Rule action.
35. IP Server shall support integration with Network speaker.
36. IP Server shall support Shard DB environment and allow user to login to all managed IP Servers by single IP Server credential input.
37. IP Server shall have a capability to store and search User Audit log such as camera control, configuration update (including camera, map, server rule, user and view), force record, Guard Tour, Live Viewing, login/out, export video clip and playback.
38. The User Audit log shall be able to be exported.
39. IP Server shall have an option to allow user to login from only one client.
40. IP Server shall support HTTPS communication including video streaming with camera. And Panasonic i-PRO camera's pre-installed certificate can be verified.

2.02 VI MONITOR PLUS WINDOWS CLIENT

1. VI MonitorPlus will be a thick client for viewing live and recorded video, along with handling administrative tasks.
2. The software shall not require a client license to operate.
3. The thick client shall support an encrypted XML file for storing settings. The file can be set up to be shared between many clients, allowing the administrator to update all clients with a single file push.

4. Clients shall be able to use Active Directory to authenticate users.
5. Clients shall be able to use Novell E-directory to authenticate users.
6. VI MonitorPlus shall have a searchable timeline for multiple events:
    a. Motion.
    b. Access Control.
    c. Rules.
    d. LPR (License Plate Recognition).
    e. VCA (Video Content Analytic).
7. VI MonitorPlus shall display the servers it is connected to along with the server's cameras in a tree view on the left-hand side:
    a. The tree view shall allow the user to see the status of the servers that the instance of VI MonitorPlus is aware of.
    b. The tree view shall also include access to custom layouts, facility maps and action buttons.
    c. There shall be an option to hide the tree on startup of VI MonitorPlus.
    d. The user shall be able search for cameras using a searchable box on the left-hand tree.
8. The thick client shall not be limited in the number of servers it can connect to.
9. Live view shall allow views of 1, 2, 4, 8, 9, 10, 13, 16, 18(wide), 19, 24(wide), 25, 36, 48 and 64 cameras. A widescreen option for 18 and 24 cameras shall also be available:
    a. Layouts shall be selectable via icon.
    b. Layouts shall not be limited to cameras from a single server.
    c. Users shall be able to get layouts to cycle in the client's workspaces.
    d. Layouts shall be able to be put into groups.
10. If motion is detected on a camera, the software shall have the option to indicate it by highlighting the edge of the live window.
11. Live view shall allow cameras to be dragged and dropped onto the live view from the left-hand tree. Cameras can be duplicated in a view.
12. Users shall be able to invoke a digital zoom by drawing a box.
13. After invoking the digital zoom, VI MonitorPlus shall support the use of picture in picture within the zoomed image.
14. Digitally zoomed areas shall be treated as a digital PTZ.
15. PTZ Presets shall be listed in a drop-down menu in the Dynamic Tab.
16. Users shall be able to move the PTZ movements simply by clicking on the image, through onscreen PTZ controls. Zoom functionality can also be controlled via the scroll wheel of the mouse.
17. Live view shall support a full screen mode that hides the UI. User shall be able to start VI MonitorPlus in this full screen mode with a setting.
18. Live view shall allow the user to de-warping the video from panoramic lenses and cameras.
19. Right clicking on a camera in live view shall have the following behaviors:
    a. Right-clicking on a camera within live view shall allow the user to be able to review the recently recorded video for that camera.

b. Right-clicking on a camera within live view shall also allow access to the properties dialog box for that camera.
c. Allowing access to recorded video.
d. Right-clicking on the Camera tile shall allow the users to send video or messages to other users or Video wall in the form of a popup window.

20. VI MonitorPlus shall have a control panel inside of camera view and allow the below controls:
    a. Save a still image of the live view.
    b. PTZ control.
    c. Display video streaming information on video.
    d. Force recording.
    e. Show bounding box of detected objects such like people, vehicle, and face etc. by resulting video analytics.
    f. Auto focus.
21. Up to 16 Recorded video Synchronized playback shall allow for cameras to simply be dragged and dropped into the player.
22. The exporting of video in VI MonitorPlus shall have Region of Interest capability within a recorded image. This will enable segregation of image for export.
23. VI MonitorPlus shall be able to display logging information such as: changes to the server, lost camera signals, who exported recorded video, when did users log-on/off and other errors. This functionality will be limited to administrative users. The log will be exportable as txt or to the Windows clipboard.
24. VI MonitorPlus shall also provide real time status updates for server status and camera status, including the CPU usage, disk usage, bandwidth usage, licensing and number, motion event, edge storage, and names of users who are logged in.
25. The system shall support an Alarm Log to make it easier to find DIO based events.
26. Facility maps shall be available in the software for viewing:
    a. When the user hovers over a camera in the facility map it shall display the camera in a window off the side of the map.
    b. While a camera is displayed it shall allow access to recorded video from that camera as well as the live stream.
    c. Cameras shall display where they are pointed.
    d. Embedded layouts shall change the layout of VI MonitorPlus if they are clicked on.
    e. Embedded Facility maps shall cause the current map to change to the embedded map if clicked on.
    f. The user shall have the option of importing and placing doors from supported access control partners on the map. This shall allow them to see badge events as well as alarm events. It shall also support the ability to lock and unlock doors from the map.
    g. Integrated Panic button events will be visible on the facility map.
27. VI MonitorPlus will support the DCZ Joystick, Panasonic i-PRO WV-CU950&WV-CU980, and as well as standard USB joysticks.

28. The software shall support the ability to open a live window that can be moved around. This window will be able to access the view of any camera or layout the user has access to.
29. VI MonitorPlus shall support multiple screen user environments for dynamic user interface.
30. The user shall be able to enable or disable the following settings:
    a. Server name in the live view.
    b. Camera Name in the live view.
    c. Audio notification on motion.
    d. Forcing aspect ratio.
    e. Use Direct Show for display.
    f. Double clicking to change the server layout.
    g. Double clicking expands the camera.
    h. Allowing multiple live windows.
    i. Block live windows from popping up.
    j. Live window always on top.
    k. The speed in which layouts cycle.
    l. Hiding left tree on start up.
    m. Launching Facility maps on start up.
    n. Auto login.
    o. Select Startup View.
31. Users with Administrator privileges shall be able to configure the server and camera settings. Users will also be able to test SMTP settings and database settings:
    a. Users shall be able to configure the framerate of the camera, including the option to have the server record continuously from 1 to 3 fps with the option to go to the cameras designated frame rate on motion detection.
    b. Users shall be able to select various time-lapse options for the camera.
    c. Users shall be able to select the camera stream type.
    d. Users shall be able to select camera or server-side motion detection.
32. Users shall be able to access a graphic representation of what the server's motion detection settings are picking up through the timeline. Analytics and bookmark also can be display in a timeline.
33. Users shall be able to configure user settings as well as layout settings from within the thick client.
34. VI MonitorPlus shall allow users to send video to other users who is using VI MonitorPlus, allowing for remote live pop ups of video of important events.
35. VI MonitorPlus shall allow users to send video or video view to Video Wall application.
36. VI MonitorPlus shall support Layout touring. Selecting a layout will cycle through a list of cameras.
37. VI MonitorPlus shall allow Region of Interest searches (a.k.a. Smart Search functionality).

38. VI MonitorPlus shall support quad mode and double panorama mode dewarping for supported 360 degrees cameras. And these dewarping mode shall be changed easily by clicking control icons.
39. VI MonitorPlus shall support 3D dewarping for Panasonic i-PRO 360 degrees cameras.
40. VI MonitorPlus shall have a capable to playback a video of cameras which are under Panasonic embedded recorder.
41. VI MonitorPlus shall have a capable to install Plug-in and open the Plug-in form in workspace.
42. VI MonitorPlus shall have a capability to configure AI-VMD analytics setting of i-PRO AI camera. The configuration shall be set via IP Server.

2.03 WEB CLIENT

1. The Web Client shall support Chrome, and Microsoft Edge browsers.
2. The Web Client shall not be limited to only Windows platforms.
3. The Web Client shall not require a license for basic features.
4. The Web Client shall allow user to login single server or multiple servers.
5. The Web Client shall allow to be used by Active Directory users and group users.
6. The Web Client shall be able to display compressed streaming which are MJPEG, H.264 and H.265 without server-side decoding or Active X.
7. The Web Client shall have an option to select the streaming type which are MJPEG and MP4.
8. The Web Client shall have an option to select the video display type which are the maintain aspect ratio, the stretch and the actual size.
9. Web Client users shall be able to select layouts for live viewing, individual cameras, or groups of cameras.
10. Web Client users shall be able to search camera, server, view and map by filling characters.
11. Web Client users shall be able to access recorded video.
12. The Web Client shall be able to highlight days on the calendar if there is a recorded video.
13. Web Client users shall be able to download recorded video from the system.
14. Web Client users shall be able to use the motion log or timeline to find recorded video.
15. The Web Client shall support the use of facility maps and allow to show Live and Playback from a camera icon on the facility map.
16. Web Client users shall be able to see live video in hover when mouse over a camera icon on the facility map.
17. Web Client users shall be able to zoom in and out the facility map.
18. The Web Client shall use IIS as its web server.

2.04 VI iOS MOBILE APPLICATION

1. The iPhone/iPad application shall not require a license to operate.
2. The App shall have access to live and recorded video.
3. PTZ functionality shall be available in the App.
4. Facility map functionality shall be available.
5. Snapshots shall be able to be e-mailed from the App.
6. The app shall provide optional access control functionality.
7. The app shall provide multi-camera views
8. The app shall stream H.264, H.265, and JPEG video.

2.05 ANDROID VI MOBILE PLUS

1. The Android application shall not require a license to operate.
2. The App shall have access to live cameras.
3. PTZ functionality shall be available in the App.
4. The App shall have access to recorded video.
5. Facility map functionality be available.
6. The app shall provide optional access control functionality.
7. The app shall stream H.264 and JPEG video.

2.06 APPLE TV APPLICATION

1. The Apple TV application shall have access to live cameras.
2. The Apple TV application shall have access to recorded video.
3. The app shall require an internet connection.
4. The app shall require a license per server; number of Apple TVs is not limited by license.
5. The app shall make available camera tours.
6. The app shall stream H.264, H.265, and JPEG video.
7. The app shall provide dewarping for fish-eye cameras.
8. The app shall provide multi-camera views.
9. The app shall allow users to create their own multi-camera views and camera tours and store them in their iCloud account.
10. The app shall provide search functionality for cameras, views, and tours.
11. The app shall allow users to select cameras, views, and tours as favorites for quick access.
12. The app shall allow users to select a camera, view, or tour as default start-up content.

2.07 MAC CLIENT

1. The app shall not require a license.
2. The app shall have available live and recorded video.
3. The app shall stream H.264, H.265, and JPEG video.
4. The app shall include PTZ functionality.

5. The app shall create snapshots.
6. The app shall include multi-camera views up, to 64 cameras per view.
7. The app shall include access control functionality.
8. The app shall include available facility maps.
9. The app shall include audio support for live and recorded video.
10. The app shall dewarp fish-eye cameras (quad mode, single quadrant mode, single and double panorama modes).
11. The app shall include a timeline.
12. The app shall include video clipping.
13. The app shall include synchronized playback.
14. The app shall allow users to create desktop views and save them as default start-up content.
15. The app shall allow users to create and view bookmarks.

2.08 VIDEO ANALYTICS APPLICATION, MULTI-AI

1. The VMS shall provide a Multi-AI System solution that supports cutting edge intelligent search with the combination of i-PRO camera and deep learning technology.
2. The Multi-AI System shall be structured mainly by the Multi-AI server, the i-PRO camera that has deep learning technology, the Multi-AI Plug-in that can be installed to VI MonitorPlus and IP Server.
3. The Multi-AI System shall not require a license to operate.
4. The Multi-AI server shall be designed to run on a Windows platform, supporting both Desktop and Server class operating systems including Windows 10 (Pro), 2016 and 2019.
5. It shall run as a Window's Service. This service shall be running as long as the system is booted and has started Windows.
6. It shall store settings and detected objects which are best shot images and metadata captured by i-PRO network cameras in SQL Server 2014/2016 Express/Standard Edition.
7. The Multi-AI server shall have the option to be installed with VI IP Server or in dedicated server.
8. The Multi-AI System shall work with the Multi-AI Plug-in software that is installed in VI MonitorPlus..
9. The Multi-AI server shall store face watch list up to 1,000, and person watch list up to 12. These list shall be used to detect a person in Live monitoring.
10. The Multi-AI System shall collate metadata with the watch list registered in the client software and issues an alarm when a match is found.
11. The Multi-AI Plug-in shall be able to search recorded best shot thumbnails with specified conditions by using search filter:
    a. Face best shot.
       Registered face shall be used as filter.

b. Person best shot.
   Gender, Age, Hair type, Hair color, Top type, Top color, Bottom type, Bottom color, Sunglasses, Beard, Mask and Moving Direction shall be used as filter which is included or excluded. And the threshold shall allow to be changed per search.
c. Vehicle best shot.
   Car Type, Color and Moving direction shall be used as filter which is included or excluded. And the threshold shall allow to be changed per search.

12. The client software shall monitor live events and search past events with specified conditions by using search filter:
    a. AI Face Detection, which a registered face is detected.
    b. AI People Detection, which a registered watch list is detected.
    c. AI-VMD (Intruder/Loitering/Cross line/Direction).
    d. AI Sound Classification (Gunshot/Yell/Vehicle horn/Glass break).
13. The Multi-AI Plug-in shall playback a detected object. And the playback shall be continuing or repeating the recorded video.
14. The Multi-AI System shall provide mobile solution (VI Guard) for iOS and Android.
15. The VI Guard shall be able to connect Multi-AI System via Wi-Fi or Cellular network.
16. The VI Guard shall allow users to search an interested person or vehicle by filtering cameras and object appearance.
17. The VI Guard shall receive and display a notification for each alarm.
18. The VI Guard shall allow user to show a camera location on map.
19. The VI Guard shall allow user to show live & playback for camera that had an event.
20. The Multi-AI Plug-in shall be able to send a message with detected object to VI Guard.

2.09 ANALYTICS SYSTEM INTEGRATION

1. The VMS shall be integrated with the below analytics system or application:
   a. i-PRO FacePro.
   b. i-PRO Vehicle Search.
   c. BriefCam
   d. ZeroEyes.
2. Third party applications must be configured and licensed according to the requirements of the third-party analytics provider

2.10 VI HEALTH MONITOR PLUS (Optional)

1. VI Health Monitor can be enabled with a separate license to allow for supervision and maintenance of the VMS system and it's connected cameras.
2. If Health Monitor detects anything abnormal, it will give a visual display through a web front end, or by sending out an e-mail to one or more users.

3. The status of VMS servers and cameras shall be summarized in the web front end.
4. The server's up/down status detail shall be displayed with resource status such as CPU usage, memory usage and free storage space.
5. CPU usage, Memory usage and Free disk space shall be able to be confirmed as graphical diagram.
6. The camera's up/down event shall be displayed in the event list. And the detail information of cameras shall be displayed, which are Maker, model, resolution, framerate, bandwidth and last writing/receiving time.
7. It shall be hosted locally or across the internet.
8. The Health Monitor software shall run as a service.
9. Health Monitor shall allow user to reset a password.
10. VMS server shall be enrolled via a web front end.
11. VMS server shall be able to be enrolled by using a bulk import.
12. Current status report shall be exported as CSV/PDF/HTML.
13. Transaction report shall be exported as CSV/PDF/HTML.

2.11 VI VIDEO WALL PLUS (Optional)

1. Video WallPlus is an optional feature that can be enabled with a separate license to enable management of workstation connected displays from a single control panel.
2. Video WallPlus shall support an unlimited number of monitors.
3. Video WallPlus shall support up to four monitors per workstation.
4. Video WallPlus shall support live view (Single/Multi).
5. Video WallPlus shall support cycle view for configured layout.
6. Video WallPlus shall allow to setup display view per monitor.
7. Video WallPlus shall allow to show views of 1, 2, 4, 8, 9, 10, 13, 16, 18(wide), 19, 24(wide), 25, 36, 48 and 64 cameras.
8. The user shall be able to send a camera view to the display of Video WallPlus via the VI MonitorPlus client.
9. The user shall be able to control the monitor display and PTZ camera position by i-PRO network Joystick.
10. Video WallPlus shall be able to make direct camera connects.
11. Video WallPlus shall support failover.
12. Video WallPlus shall be able to receive second streaming as low resolution.
13. Video WallPlus shall be able to indicate recording status.
14. Video WallPlus shall have option to select to use hardware decoding.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site conditions to determine site conditions are acceptable without qualifications. Notify Owner in writing if deficiencies are found. Starting work is evidence that site conditions are acceptable.

3.02 INSTALLATION

A. Integrated Security Management System, including but not limited to access control, alarm monitoring, CCTV, and ID badging system shall be installed in accordance with the manufacturer's installation instructions.

B. Supervise installation to appraise ongoing progress of other trades and contracts, make allowances for all ongoing work, and coordinate the requirements of the installation of the Security Management System.

3.03 FIELD TESTING AND CERTIFICATION

A. Testing: The access control, alarm monitoring, CCTV, and ID badging system shall be tested in accordance with the following:

1. Conduct a complete inspection and test of all installed access control and security monitoring equipment. This includes testing and verifying connection to equipment of other divisions such as life safety and elevators.

2. Provide staff to test all devices and all operational features of the Security Management System for witness by the Owner's representative and authorities having jurisdiction as applicable.

3. Correct deficiencies until satisfactory results are obtained.

4. Submit written copies of test results.

END OF SECTION 28 2313

SECTION 28 3100 – FIRE DETECTION AND ALARM

PART 1.0 GENERAL

1.1 RELATED SECTIONS

A. Section 26050 – General Electrical Provisions.

1.2 DESCRIPTION

A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire detection 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.

B. 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.

1. The Secondary Power Source of the fire alarm control panel will be capable of providing at least 24 hours of backup power with the ability to sustain 5 minutes in alarm at the end of the backup period.

C. The fire alarm system shall comply with requirements of NFPA Standard No. 72 for Auxiliary Protected Premises Signaling Systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.

1. The Secondary Power Source of the fire alarm control panel will be capable of providing at least 60 hours of backup power with the ability to sustain 5 minutes in alarm at the end of the backup period.
2. The Secondary Power Source installed in a system backed up by a generator need to supply 4 hours of backup power.

D. The fire alarm system shall be manufactured by an ISO 9001 certified company.

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 II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

1.3 SCOPE:

A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

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), NFPA Style 6 (Class A) or NFPA 7 (Class A) Signaling Line Circuits (SLC).
2. 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 (NFPA Style Y) or Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
4. All circuits shall be power-limited, UL864 9th edition requirements.
5. 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 when wired NFPA Style 6/7.
6. Alarm signals arriving at the main FACP shall not be lost following a primary power failure or outage of any kind 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 80-character LCD display on the FACP shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. In response to a fire alarm condition, the system will process all control programming and activate all system outputs (alarm notification appliances and/or relays) associated with the point(s) in alarm.

1.4 SUBMITTALS

A. General:

1. Two copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent

compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

3. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. 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.

C. 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.

D. 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.

E. 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 GUARANTY:

A. 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.

1.6 POST CONTRACT MAINTENANCE:

A. Maintenance and testing shall be on a semi-annual schedule or as required by the local 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 (2002 Edition) Chapter 10.

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.

1.7 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 control 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.

1.8 APPLICABLE STANDARDS AND SPECIFICATIONS:

A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

B. National Fire Protection Association (NFPA) - USA:

1. No. 13 Sprinkler Systems
2. No. 70 National Electric Code (NEC)
3. No. 72 National Fire Alarm Code
4. No. 101 Life Safety Code

C. Underwriters Laboratories Inc. (UL) - USA:

1. No. 38 Manually Actuated Signaling Boxes
2. No. 50 Cabinets and Boxes
3. No. 864 Control Units for Fire Protective Signaling Systems
4. No. 268 Smoke Detectors for Fire Protective Signaling Systems
5. No. 268A Smoke Detectors for Duct Applications
6. No. 346 Waterflow Indicators for Fire Protective Signaling Systems
7. No. 464 Audible Signaling Appliances
8. No. 521 Heat Detectors for Fire Protective Signaling Systems
9. No. 1971 Visual Notification Appliances

D. Local and State Building Codes.

E. All requirements of the Authority Having Jurisdiction (AHJ).

1.9 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

1. UL Underwriters Laboratories Inc
2. ULC Underwriters Laboratories Canada
3. FM Factory Mutual
4. NYFD New York Fire Department
5. CSFM California State Fire Marshal

B. The system shall be certified for seismic applications in accordance with the International Building Code (IBC). For OSHPD applications in California the system shall be Pre-Approved for seismic applications. The basis for qualification of seismic approval shall be via shake table testing.

PART 2.0 PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

B. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

C. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

D. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 CONDUIT AND WIRE:

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where required, 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.
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 back boxes, 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 detection system. Number and size of conductors shall be as recommended by the fire detection system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits, Signaling Line Circuits and 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 support a minimum wiring distance of 10,000 feet when sized at 12 AWG. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit. Shielded wire shall not be required.
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 which do not allow or have restrictions in, for example, the amount of T-taps, length of T-taps etc., is not acceptable.

C. Terminal Boxes, Junction Boxes and Cabinets:
   1. All boxes and cabinets shall be UL listed for their use and purpose.

D. 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.

E. The control panel enclosure shall feature a quick removal chassis to facilitate rapid replacement of the FACP electronics.

2.3 MAIN FIRE ALARM CONTROL PANEL:

A. The FACP shall be as manufactured by Potter Electronics or Silent Knight, similar and equal, 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.

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 80-character 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 system LEDs and light each segment of the liquid crystal display.

C. System Capacity and General Operation

1. The control panel shall provide, or be capable of, expansion to 198 intelligent/addressable devices.
2. The control panel shall include Form-C Alarm, Trouble and Supervisory relays rated at a minimum of 2.0 amps @ 30 VDC. It shall also include programmable Notification Appliance Circuits (NACs) capable of being wired as Class B (NFPA Style Y) or Class A (NFPA Style Z).
3. The fire alarm control panel shall include an 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 for the field programming and control of the fire alarm system.
4. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. The system shall be fully 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. The control unit will support the ability to upgrade its operating program using FLASH memory

technology. The unit shall provide the user with the ability to program from either the included keypad, a standard PS2-style PC keyboard or from a computer running upload/download software.

5. The system shall allow the programming of any input to activate any output or group of outputs. Systems which 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.
6. The FACP shall provide the following features:

   a. Drift compensation to extend detector accuracy during the accumulation of dust and foreign material.
   b. Detector sensitivity test, meeting requirements of NFPA 72, Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
   c. The ability to display or print system reports.
   d. Alarm verification.
   e. Positive Alarm Sequence (PAS presignal), meeting NFPA 72 (2002 Edition) 6.8.1.3 requirements
   f. Rapid manual station reporting.
   g. Non-alarm points for general (non-fire) control.
   h. Periodic detector test, conducted automatically by the software.
   i. Walk test, with a check for two detectors set to same address.

7. The FACP shall be capable of coding Notification Appliance Circuits in March Time Code (120 PPM), Temporal (NFPA 72), and California Code. Main panel notification circuits (NACs 1 & 2) shall also automatically synchronize the following manufacturer's notification appliances connected to them: System Sensor, Wheelock, or Gentex with no need for additional synchronization modules.

D. Central Processing Unit

1. The microprocessor shall be a state-of-the-art; high speed device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, non-volatile 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 specific actions to be taken in the condition of an alarm. Control programming 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.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-programming capability (self-learn) shall be provided to quickly identify devices connected on the SLC 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. 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 incompliance with the NFPA 72 requirements for testing after system modification.

E. Local Keyboard Interface

1. In addition to an integral keypad, the fire alarm control panel will accept a standard PS2style keyboard for programming, testing, and control of the system. The keyboard will be able to execute the system functions ACKNOWLEDGE, SIGNALS SILENCED, DRILL and RESET.

F. Display

1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
3. The display shall contain an alphanumeric, text-type display and dedicated LEDs for the annunciation of AC POWER, FIRE ALARM, SUPERVISORY, TROUBLE, MAINTENANCE, ALARM SILENCED, DISABLED, BATTERY, and GROUND conditions.
4. The display keypad 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.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, DRILL (alarm activate), and SYSTEM RESET.

G. Signaling Line Circuit (SLC)

1. The SLC interface shall provide power to and communicate with up to 99 intelligent detectors (ionization, photoelectric or thermal) and 99 intelligent modules (monitor or control) for a system capacity of 198 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. The CPU shall receive information from all intelligent detectors to be processed to determine whether normal, alarm, or trouble conditions exist for each detector. The software shall automatically compensate for the accumulation of dust in each detector up to allowable limits. The information shall also be used for automatic detector testing and for the determination of detector maintenance conditions.
3. The detector software shall meet NFPA 72 requirements and be certified by UL as a calibrated sensitivity test instrument.

H. Serial Interfaces

1. The system shall provide a means of interfacing to UL Listed Electronic Data Processing (EDP) peripherals using the EIA-232 communications standard.
2. One EIA-232 interface shall be used to connect an UL-Listed 80-column printer. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association standard EIA-232D. Power to the printer shall be 120 VAC @ 60 Hz.

I. The control panel will have the capability of Reverse Polarity Transmission or connection to a Municipal Box for compliance with applicable NFPA standards.

J. Digital Alarm Communicator Transmitter (DACT) and IP Internet & GSM Dual Path Communicator. The DACT is an interface for communicating digital information between a fire alarm control panel and a UL-Listed central station.

1. The DACT shall be an integral component of the fire alarm control panel requiring no interconnecting wiring, plug-in module or supervisory circuitry.
2. The DACT 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 two different telephone numbers.
3. The DACT shall be completely field programmable locally from the control panel keypad or via PC software connected to the panel serial port. The DACT shall support upload/download of programming parameters from a remote location over a phone line using upload/download PC software
4. The DACT shall be capable of transmitting events in Contact ID, SIA 8 and SIA 20 formats. This ensures compatibility with existing and future transmission formats.
5. Communication shall include vital system status such as:

   a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
   b. Independent Addressable Device Status
   c. AC (Mains) Power Loss
   d. Low Battery and Earth Fault
   e. System Off Normal
   f. 12 and 24-Hour Test Signal
   g. Abnormal Test Signal (per UL requirements)
   h. EIA-485 Communications Failure
   i. Phone Line Failure
6. The DACT shall support independent zone/point reporting when used in the Contact ID format. In this format, the DACT shall support the transmission of all input addressable points with the system. This format shall enable the central station to have exact details concerning the location of the fire for emergency response.
7. #IPGSM-4GC IP Internet and GSM Dual Path Communicator shall be available to interface to the DACT and be capable of transmitting signals over the internet/intranet or Cellular (GSM) to a compatible receiver.

K. 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 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall provide for the viewing of all indicators.
4. The cabinet shall accept a chassis containing the PCB and to assist in quick replacement of all the electronics including power supply shall require no more than two bolts to secure the panel to the enclosure back box.

L. Field Charging Power Supply (FCPS)

1. The FCPS-24S6/8 is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.
2. The FCPS-24S6 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 up to 18.0 amp hour batteries and to support 60 hour standby. The FCPS-24S8 shall offer up to 8.0 amps (6.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge up to 18.0 amp hour batteries and to support 60 hour standby.
   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 (Style Y or Z) shall be available for connection to the Notification devices.
3. The Field Charging Power Supply shall include an attractive surface mount back box.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
5. The Field Charging Power Supply includes power limited circuitry, per UL standards.
6. The Field Charging Power Supply shall use the same key type as the fire alarm control panel and fire command center.

M. Power Supply:

1. The main power supply for the fire alarm control panel shall provide up to 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 or may be used with an external battery and charger systems. Battery arrangement may be configured in the field.
4. The main power supply shall continuously monitor all field wires for earth ground conditions.
5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.

2.4 SYSTEM COMPONENTS:

A. Programmable Electronic Sounders:

1. Electronic sounders shall operate on 24 VDC nominal.
2. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
3. Shall be flush or surface mounted as shown on plans.

B. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

1. The maximum pulse duration shall be 2/10 of one second.
2. Strobe intensity shall meet the requirements of UL 1971.
3. The flash rate shall meet the requirements of UL 1971.

C. 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.

D. Conventional Photoelectric Area Smoke Detectors

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.

E. Conventional Ionization Type Area Smoke Detectors

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.

F. Duct Smoke Detectors

1. Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

G. Projected Beam Detectors

1. The projected beam type shall be a 4-wire 24 VDC device.
2. The detector shall be listed to UL 268 and shall consist of a separate transmitter and receiver capable of being powered separately or together.
3. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
4. The temperature range of the device shall be -22 degrees F to 131 degrees F.
5. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
6. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
7. The unit shall be both ceiling and wall mountable.
8. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

H. OSID Detection

1. Open-area Smoke Imaging Detector shall be an available option. The OSID projected beam detector shall use UV (ultraviolet) and IR (infrared) technology to detect the presence of smoke, while providing nuisance alarm rejection.
2. The detector shall use an imager to measure the level of smoke based on the readings between the emitters and the imager, up to 7 emitters shall be supported.

3. The detector shall operate from 24 VDC
4. The detector shall be able to provide up to 80 degree wide viewing angle
5. The detector shall provide selectable alarm thresholds
6. The detector shall provide alarm and trouble relays used to activate a fire alarm control panel.

I. Aspirating Detection

1. An optional air aspiration detection system shall be available.
2. The aspirating system shall support multiple sensitivity settings.
3. The aspirating system shall operate from 24 VDC.
4. The aspirating system shall provide alarm and trouble relays used to activate a fire alarm control panel.

J. Automatic Conventional Heat Detectors

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).

K. Waterflow Indicator:

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.

L. Sprinkler and Standpipe Valve Supervisory Switches:
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.

M. Specific System Operations

1. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently programmed for verification of alarm signals. The alarm verification time period shall not exceed 2 minutes.
2. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
3. Point Read: The system shall be able to display the following point status diagnostic functions:

    a. Device status
    b. Device type
    c. Custom device label
    d. Device zone assignments

4. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 1000 events. 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.
6. 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. 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. The fire alarm control panel shall include Silent and Audible Walk Test functions - Silent and Audible. 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. The operation shall be as follows:

a. The Silent Walk Test will not sound NACs but will store the Walk Test information in History for later viewing.
b. Alarming an initiating device shall activate programmed outputs, which are selected to participate in Walk Test.
c. Introducing a trouble into the initiating device shall activate the programmed outputs.
d. Walk Test shall be selectable on a per device/circuit basis. All devices and circuits which are not selected for Walk Test shall continue to provide fire protection and if an alarm is detected, will exit Walk Test and activate all programmed alarm functions.
e. All devices tested in walk test shall be recorded in the history buffer.

9. Waterflow Operation

    a. An alarm from a waterflow detection device shall activate the appropriate alarm message on the control panel display; turn on all programmed Notification Appliance Circuits and shall not be affected by the Signal Silence switch.

10. Supervisory Operation

    a. An alarm from a supervisory device shall cause the appropriate indication on the control panel display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

11. Signal Silence Operation

    a. The FACP shall have the ability to program each output circuit (notification circuit or relay) to deactivate upon depression of the Signal Silence switch.

12. Non-Alarm Input Operation

    a. 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.

2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General

1. Addressable devices shall employ the simple-to-set decade addressing scheme. Addressable devices which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
2. Detectors shall be addressable and intelligent, and shall connect with two wires to the fire alarm control panel signaling line circuits.

3. Addressable smoke and thermal (heat) detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash 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 illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.
   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.
4. Detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a base with a built-in (local) sounder rated for a minimum of 85 DBA, a relay base and an isolator base designed for Style 7 applications.
5. Detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
6. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
   Detectors shall provide address-setting means using decimal switches.

B. Addressable Manual Fire Alarm Box (manual station)

1. Addressable pull 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.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. The detectors shall be ceiling-mounted and available in an alternate model with an integral fixed 135-degree heat-sensing element.
3. Each detector shall contain a remote LED output and a built-in test switch.
4. Detector shall be provided on a twist-lock base.
5. 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.
6. 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 periodically flash to indicate that the detector is in communication with the control panel.

7. The detector shall not go into alarm when exposed to air velocities of up to 1500 feet per minute (fpm).
8. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
9. All field wire connections shall be made to the base through the use of a clamping plate and screw.

D. Intelligent Multi Criteria Detector

1. The intelligent multi criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
2. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal to provide a quick response in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

E. Intelligent Ionization Smoke Detector

1. The detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.

F. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute
2. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available
3. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.

G. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel.

2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

H. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any normally open dry contact device) to one of the fire alarm control panel SLCs.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. 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.
4. 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.
5. For multiple dry contact monitoring a module shall be available that provides 10 Style B or 5 Style D input circuits.

I. Two Wire Detector Monitor Module

1. Means shall be provided for the monitoring of conventional Initiating Device Circuits populated with 2-wire smoke detectors as well as normally open contact alarm initiating devices (pull stations, heat detectors, etc).
2. Each IDC of conventional devices will be monitored as a distinct address on the polling circuit by an addressable module. The module will supervise the IDC for alarms and circuit integrity (opens).
3. The monitoring module will be compatible, and listed as such, with all devices on the supervised circuit.
4. 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.
5. The monitoring module shall be capable of mounting in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or in a surface mount back box.
6. For multiple 2-wire smoke detector circuit monitoring a module shall be available that provides 6 Style B or 3 Style D input circuits.

J. Addressable Control Module

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 a current rating of 2 Amps for Style Z and 3 Amps for Style Y.

3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.

K. Addressable Relay Module

1. Addressable Relay Modules shall be available for HVAC control and other network building functions.
2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.

L. Isolator Module

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.

M. Serially Connected Annunciators

1. The annunciators shall communicate with the fire alarm control panel via a two wire EIA 485 (multi-drop) communications circuit.
2. The annunciator shall require no more than four wires for operation. Annunciation shall include: intelligent addressable points, system software zones, control relays, and notification appliance circuits. The following operations shall also be provided:

    a. Up to 32 annunciators, each with up to 64 points may be installed on the system.
    b. The annunciator shall include a single electrical key switch to disable all switch functions.
    c. The annunciator shall provide alarm and trouble resound, with flash for new conditions.
    d. This unit shall provide for each zone: alarm indications, using a red alarm and yellow trouble LEDs, and 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.

e. 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.

3. This system shall provide a means of interfacing to graphic style annunciator.
4. The graphic annunciator interface will possess the capability of individually annunciating each individual addressable device in the system.
5. The system shall provide the option to interface to either ACS type annunciators or to ANN-BUS annunciator devices.
6. For ANN-BUS operation the system shall support a secondary ANN-BUS. ANN-BUS devices include the following:

   a. 80-character LCD annunciator capable of remote control of system acknowledge, silence and reset.
   b. LED annunciator capable of remote control of system acknowledge, silence and reset.
   c. LED driver module to interface to custom graphic annunciators.
   d. Printer driver module capable of supporting a serial or parallel printer.
   e. Relay module providing ten programmable relays.

N. Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located backlit 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.

O. Door Holders:

1. Door Holders will be available in 120 VAC and 24 VDC models.
2. 120 VAC models will be transient-protected against surges up to 600 volts.
3. Door holders will be designed for Fail Safe operation (power failure release door to close).

P. Elevator Recall:

1. Smoke detectors will be installed in the elevator hoist shaft. An alarm from such devices will signal the elevator to initiate emergency procedures. All lift call buttons; door buttons and signals will become inoperative in the lift bank serving the machine room. Lifts will immediately be sent to the main floor of egress (ground level) where they will be

decommissioned until the alarm condition has been cleared or manually taken over by Fire Department personnel.

2. Smoke detectors will be installed in each elevator lobby. These detectors will function to signal the elevator to recall to the primary floor of egress (ground level) in the event of an alarm. Detectors on the first floor will signal the elevator to recall to the secondary floor of egress.

2.6 BATTERIES AND EXTERNAL CHARGER:

A. Battery:

1. The battery shall have sufficient capacity to power the fire detection system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
2. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
3. If necessary to meet standby requirements, external battery and charger systems may be used.

PART 3.0 EXECUTION

3.1 INSTALLATION:

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

3.2 TEST:

A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

D. Verify activation of all flow switches.

E. Open initiating device circuits and verify that the trouble signal actuates.

F. Open signaling line circuits and verify that the trouble signal actuates.

G. Open and short notification appliance circuits and verify that trouble signal actuates.

H. Ground initiating device circuits and verify response of trouble signals.

I. Ground signaling line circuits and verify response of trouble signals.

J. Ground notification appliance circuits and verify response of trouble signals.

K. Check presence and audibility of tone at all alarm notification devices.

L. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.

M. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

END OF SECTION 28 3100

SECTION 31 2000 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Extent of earthwork is indicated on drawings.

1. Preparation of subgrade for building slabs, walks, and pavements is included as part of this work.

2. Clearing, grubbing, and removal of obstructions.

3. Preparation of subgrade; Compacted fill under and around structures and paving areas; Excavation and backfilling; Trenching and backfilling for utility lines; Site grading.

B. Definition: "Excavation" consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork and site grading work in compliance with the applicable codes and requirements of governing authorities having jurisdiction.

B. Testing and Inspection Service: The Owner will employ a testing laboratory to perform soil testing and inspection service for quality control testing during earthwork operations. It is the full responsibility of the Contractor to conform to the recommendations as set forth in the report dated 3/26/18 prepared by Geo-Test, Inc. (Job No. 1-80201). It is also the full responsibility of the Owner to coordinate scheduling 15 days in advance of any anticipated excavation, grading, and placement of engineered fill with Architect and Owner employed testing agency.

1.4 SUBMITTALS

Test Reports-Excavating: Submit 2 copies of the following reports directly to Architect from testing services, with 1 copy to the Owner and amount of copies as required by the Contractor for his use:

1. Test reports on borrow material.

2. Verification of each footing subgrade.

3. Field density test reports.

4. One optimum moisture-maximum density curve for each type of soil encountered.

5. Bedding and trench backfill material including sieve analysis, PI determination, and the Proctor determination.

1.5 JOB CONDITIONS

A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between solid bearings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for the convenience of the Contractor.

B. Additional test borings and other exploratory operations may be made by Contractor at no cost to Owner.

C. The locations of underground utility lines and obstructions shown on the drawings are approximate and based on the best information available. No utilities other than those shown on the drawings are anticipated in the area of construction. However, the Contractor shall obtain information relating to possible hidden lines from all Public and Private Utilities and take due care in his excavation operations.

D. Existing Utilities: Locate existing underground utilities in areas of work. Provide adequate means of support and protection during earthwork operations for utilities to remain.

E. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

F. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect and then only after acceptable temporary utility services have been provided.

1. Provide minimum of 48-hour notice to Architect and receive written notice to proceed before interrupting any utility.

G. Use of Explosives: The use of explosives is not permitted.

H. Protection of Persons and Property:

1. Barricade open excavations and post with warning lights as required for the safety of persons. Protect structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations from damages caused by settlement, lateral movement, undermining, washout and other hazards.

2. Take precautions and provide necessary bracing and shoring to guard against movement or settlement of existing improvements or new construction. Contractor is entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack thereof or by movement or settlement.

I. Sampling and Testing:

1. Soil Testing and Inspection Service: Engage an approved soil testing and inspection service. Testing service will include soil survey for satisfactory soil materials, sampling, and testing soil materials proposed for use in the work, and field testing facilities for quality control testing during earthwork operations. Organization or individual who will perform testing and inspection service is subject to prior approval by the Architect.

2. Tests for Proposed Soil Materials: Test proposed soil materials and submit test reports on same day tests are conducted to Architect, for tests herein specified and for additional tests as may be required. Tests of fill materials and embankments will be made at the following suggested minimum rates: Provide one field density test for each 50 square yards of original ground surface prior to placing fill or constructing floor slabs. Provide one field density test for each 250 cubic yards of fill placed or each layer of fill for each work area, whichever is greater. Provide one moisture-density curve for each type of material used, as indicated by sieve analysis and plasticity index. Determine maximum densities in accordance with ASTM D1557, of current issue. The testing service will determine the suitability of all materials to be used as fills.

3. Quality Control During Construction: Testing service must inspect and approve all subgrades, including bedrock, and fill layers before further construction work is performed thereon.

4. The Geotechnical Engineer or his representative shall perform field density tests with a frequency and at the locations he feels appropriate. The Geotechnical Engineer or his representative will perform Proctor tests on representative samples of all fill material. To minimize delays the Earthwork Contractor is encouraged to submit soil samples prior to use for proctor testing.

PART 2 - PRODUCTS

2.1 EMBANKMENT

A. General: Embankment shall consist of controlled fill placed in areas indicated on the grading plan.

B. Materials:

1. Physical Characteristics: Embankment fill material shall consist of soils that conform to the following physical characteristics:

Seive Size (Square Openings)	Percent Passing by Weight
1 inch	100
3/4 inch	70-100
No. 4	35-85
No. 200	0-10

The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 3. Results of the soil investigation indicate that most onsite soils will meet these requirements, but some blending and imported fill may be required. The fill materials shall be free from roots and organic matter, clay lumps, rocks larger than 6 inches, or other deleterious materials.

C. Unsatisfactory Material: Other than above.

D. If in the opinion of the Architect, based on reports of the testing service and inspection, the subgrade or fills which have been placed are below the specified density, the Architect will require additional compaction and testing at the expense of the Contractor.

2.2 CLEARING & GRUBBING

A. General: Clearing and grubbing will be required for all areas shown on the plans to be excavated or on which fill is to be constructed.

B. Clearing: Clearing shall consist of removal and disposal of trees and other vegetation, down timber, snags, brush, and rubbish within the areas to be cleared. Individual trees, groups of trees, or other vegetation not required to be removed shall be protected, insofar as practical, and left standing.

C. Grubbing: Stumps, matted roots, and roots larger than 2 inches in diameter shall be removed from within 6 inches of the surface of areas on which fills are to be constructed except in roadways. Materials described above within 18 inches of finished subgrade of roadways in either cut or fill sections shall be removed. Areas disturbed by grubbing will be filled as specified.

D. Grass & Topsoil: Grass, grass roots and incidental topsoil shall not be left beneath a fill area, nor shall this material be used as fill material. Grass, grass roots and topsoil may be stockpiled and later used in the top 6 inches of fills outside roadways and building pads.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavation consists of removal and disposal of all materials encountered to obtain the required elevations. Excavations shall be made to the proper depth, with allowances made for clearances to install services and forms. Cuts shall be accurately shaped to the cross-sections and grades indicated.

B. Classification of Materials:

1. Material to be excavated is unclassified. The Contractor shall visit the site and determine for himself the classification of materials to be removed.

2. Bottoms for footings shall be level, clean, and clear of loose materials.

3. Where walls or footings are authorized to be placed without forms, the sides of the excavations shall be sharp and true. Undercutting will not be permitted.

4. Over excavations shall be filled with specified concrete type.

5. Keep earth under footings dry and free from frost. Should bearing surfaces be softened by water or frost, re-excavate to solid bearing, re-compact soil and fill with concrete of required strength at Contractor's expense.

6. Excess material from excavations which is not required for fill or backfill shall be removed from the site and legally disposed off-site.

C. Stability of Sides:

1. Slope sides of excavations over 5' deep to angle of repose of material excavated; otherwise, shore and brace where sloping is not possible either due to space restrictions or stability of material excavated.

2. Maintain sides and slopes of excavation in a safe condition.

3. Take precautions to prevent slides or cave-ins when excavations are made in locations adjacent to backfilled excavations, and when sides of excavations are subjected to vibrations from vehicular traffic or the operation of machinery, or any other sources.

D. Shoring and Bracing:

1. Provide materials for shoring and bracing, such as sheet piling, up-rights, stringers and cross-braces, in good serviceable conditions.

2. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3. Provide minimum requirements for trench shoring and bracing to comply with ANSI A10.1 "Safety Code for Building Construction", and with local codes and authorities having jurisdiction.

4. All shoring and sheeting required to perform excavation and to protect and safeguard employees of adjacent structures shall be installed.

5. Initial design of any shoring system for this project is the responsibility of prospective shoring contractors. These designs shall be based on experience with shoring system installation, subsurface information included in soils report, and available knowledge of local conditions.

E. Unauthorized Excavation:

1. Unauthorized excavation consists of removal of the material indicated below elevations without specific direction of the Architect. Replace unauthorized excavation as herein specified. Excavations for footing carried below elevations indicated on drawings shall be filled with specified footing type concrete at Contractor's expense. Excavations carried below the grades indicated for trenches shall be backfilled with suitable earth, sand, or fine gravel at Contractor's expense.

F. Dewatering:

1. Perform earthwork and site grading in a manner to prevent surface water and subsurface or ground water from flowing into excavations, and to prevent water from flooding the project site and surrounding area.

2. Do not allow water to accumulate in excavations. Remove all water from excavations using dewatering methods which will prevent softening of foundations bottoms, undercutting footings, and soil changes detrimental to stability of the subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering components necessary to convey water away from the site.

3. In no case shall "water settling" or jetting be employed. Where vibratory compaction equipment is used, it shall be Contractor's responsibility to insure that vibrations do not damage nearby buildings or other adjacent property.

4. Convey water removed from excavations and rain water to collecting or runoff areas. Provide and maintain temporary drainage ditches and other diversions. Do not use trench excavations for site utilities as temporary drainage ditches.

G. Material Storage:

1. Stockpile excavated materials classified as satisfactory soil material where directed, until required for fill; place, grade and shape stockpiles for proper drainage.

H. Excavation for Structures:

1. The building area and paved areas shall be over excavated to such an extent so as to provide a minimum of 1.0 foot of structural fill beneath all foundations, floor slabs, and pavements; however, provided that the existing subgrade soils meet the physical characteristics for structural fill, only scarification and compaction to the requirements of Section 3.2 C.5 , will be necessary.

2. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.50" and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and for other construction required, and for inspection.

3. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete is placed. Trim bottoms to required lines and grades to leave solid base to receive concrete.

I. Excavation for Trenches:

1. Excavating shall be performed to remove whatever substances are encountered. All excavating shall be made by open cut.

2. Sides of trenches shall be kept as nearly vertical as practical considering safety requirements.

3. The bottoms of trenches shall be 12” (min.) wide nor more than 16” wider than the outside diameter of the pipes or conduits to be laid therein and accurately graded for the entire length of pipe or conduit.

4. Whenever unstable or unsuitable materials, as determined by the Architect, are encountered, they shall be removed to a depth required and wasted as directed by the Architect.

5. Cuts through concrete and asphalt shall be made with a concrete saw, replace to match existing.

6. Excavated materials shall be stacked a sufficient distance back from edge of trenches to prevent slides or cave-ins.

7. All Shoring and sheeting required to perform the excavation and to protect and safeguard the employees or adjacent structures shall be installed.

8. Cuts through existing asphalt paving shall be replaced to match existing.

J. Foundation, slab and Pavement Subgrade Preparation:

1. Prior to placing reinforcement, footings, slabs, or pavement, the supporting soils shall be prepared, moisture conditioned and compacted as described herein.

3.2 COMPACTION

A. General:

1. Perform the compaction of soil materials using suitable soil compaction equipment for the materials to be compacted and the work area locations.

2. Control soil compaction during construction for compliance with percentage of maximum density specified for each area classification.

3. Prior to placement of fill, the building and paved areas shall be inspected and approved by a representative of the geotechnical engineer to insure satisfactory removal of native soils and the removal of any existing manmade fill. The exposed cut surface, as well as surfaces to receive fill, shall be scarified to a minimum depth of 8 inches and watered as necessary to bring the upper 12 inches as close as practicable to optimum moisture content or above. The upper 8 inches of the native soils shall then be compacted to a minimum of 95 percent of maximum dry density as determined in accordance with ASTM D1557.

4. Provide compaction equipment of suitable size and number (in satisfactory working condition), to complete the work on schedule and to obtain the required density throughout the entire area being compacted. Use compaction equipment which does not cause damage or settlement to existing structures, utilities or other construction. Where vibratory compaction equipment is used, it shall be the Contractor's responsibility to insure that the vibrations do not damage nearby buildings or other adjacent property.

B. Percentage of Maximum Density Requirement:

1. Provide not less than the following percentages of the maximum density of the same soil material compacted at optimum moisture content, for the actual density of each layer of soil material-in-place.

2. Structural fill shall be mechanically compacted to the following:

Minimum Compaction	(ASTM D-1557)
Foundation Support	95%
Slab Support	95%
Below Slab Utility Trenches	95%
General Site Grading	90%

Pavement Support:	
Upper 12" of Subgrade	95%
All other fill below pavement	90%

3. Aggregate Base Course shall be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557.

4. Asphaltic concrete shall be compacted to a minimum of 96% of maximum Marshall Density (75 blows).

5. Compaction by flooding and jetting is specifically prohibited unless authorized in advance by the Owner or his representative and the Geotechnical Engineer.

6. Required Degree of Compaction: Maximum density and optimum moisture content of engineered fill shall be determined in accordance with ASTM D1557. Moisture at time of compaction shall be 2% below optimum moisture or higher. For purposes of acceptance, in-place density of fill shall be defined as that determined by sand cone method (ASTM D1557) or by nuclear methods (ASTM D2922).

C. Moisture Control:

1. Provide equipment capable of adding measured amounts of moisture to the soil material as determined by moisture density relation tests. Maintain the actual moisture content in the soil material at the time of compaction between 2 percent below optimum moisture and higher.

2. Where the subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply the required amount of water to the surface of subgrade, or layer of soil material, in such a manner as to prevent free water appearing on the surface during or subsequent to compaction operations.

3. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified percentage of maximum density.

4. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread on the surface where directed by the Architect and permitted to dry. Assist drying by discing, harrowing or pulverizing, until the moisture content is reduced to a satisfactory value, as determined by moisture density relation tests. When accepted by the Architect, the soil material may be used in compacted backfill or fill.

5. All fill shall be spread in layers not exceeding 8 inches, watered as necessary, and compacted. Moisture content at the time of compaction shall be 2 percent below optimum moisture or higher. A density of not less than 95 percent of maximum dry density within the building pad and paved areas shall be obtained for the structural fill. Structural fill as well as the native soils, outside the building pad and paved areas shall be compacted to 90 percent of maximum dry density. All fill within building pad, including footing, stem wall, and utility line backfill, shall also be compacted to at least 95 percent of maximum dry density. Optimum moisture content and maximum dry density for each soil type used shall be determined in accordance with ASTM D1557.

6. Controlled fill shall not be constructed when the atmospheric temperature is below 35 degrees F. When the temperature falls below 35 degrees, it shall be the responsibility of the Contractor to protect all areas of completed work against any detrimental effects of ground freezing by methods approved by the geotechnical engineer. Any areas that are damaged by freezing shall be reconditioned, re-shaped, and compacted by the Contractor in conformance with the requirements of this specification without additional cost to the Owner.

3.3 BACKFILL AND FILL

A. General:

1. Backfill consists of the placement of specified backfill material in layers, in the excavations to the required subgrade elevations, for each area classification listed below.

2. Fill consists of the placement of specified fill materials, in layers, over the ground surface to the required elevations for each area classification.

B. Site Preparation - Fill Areas:

1. Prior to placing structural fill the areas to be filled shall be scarified to a depth of 8” and the upper 12” shall be moisture conditioned as described below. The area to be filled shall then be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-1557.

C. Site Preparation - Cut Areas:

1. Following excavation to rough grade all building and pavement areas shall be scarified to a depth of 8” and the upper 12” shall be moisture conditioned as described below. All building and paved areas shall be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-1557.

D. Backfill and Fill Materials:

1. Fill Material: Fill material shall be non-expansive soil which may be gravel, sand, or a combination thereof. Fill material shall exhibit a plasticity index of ten or less. No organic or decomposable material shall be utilized. Material larger than six inches shall not be placed in the fill without prior approval of the Owner, his representative, or the Geotechnical Engineer. Material larger than four inches shall not be placed within twelve inches of footings or slabs. All fill material shall be approved by the Geotechnical Engineer.

2. Fill Placement: Fill material shall be blended as necessary to produce a homogeneous material. Fill material shall be spread in horizontal lifts no greater than eight inches in uncompacted thickness but in no case thicker than can be properly compacted with the equipment to be utilized. If fill is to be placed on slopes steeper than 5:1 (Horizontal:Vertical) the natural ground shall be benched with minimum three foot wide benches at maximum two-foot vertical intervals.

3. Moisture Conditioning: Fill material shall be dried or moistened as necessary, prior to compacting, and shall be 2% below optimum moisture content or higher as determined by ASTM D-1557. Moisture shall be distributed uniformly throughout each lift.

4. Slope Protection & Drainage: The edges of the controlled fill embankments shall be graded to the contours shown on the drawings and compacted to the density required in paragraph (3) above. Slopes steeper than 1 vertical to 3 horizontal shall be protected from erosion.

E. Utility Trenches:

1. The trenches shall not be backfilled until the utility systems, as installed, conform to the requirements specified and all required tests are performed.

2. Fill material shall be placed in 6" layers until the utility line has a cover of not less than 1'. Each layer shall be thoroughly and carefully tamped. The remainder of the backfill shall be moistened, placed in the trench in 8" layers, and thoroughly tamped or settled.

3. Material used for pipe bedding and initial backfill shall have 100% passing the 1” screen, 40-100% passing the No. 4 screen, and up to 35% passing the No. 200 screen.

4. Open trenches under driveways, sidewalks and streets shall be backfilled as specified above, except that additional care shall be taken to tamp the fill to a density equal to that required by these specifications. If excessive settlement occurs within the guarantee period of this contract, the Contractor shall return, remove all materials to the bottom of the excavation and recompact it to meet the specification.

5. Concrete shall be replaced immediately after backfilling is completed.

F. Pavement Base Course:

1. General: Subbase course consists of placement of subbase material, in layers of specified thickness, over ground surface to support a pavement base course.

2. Subbase: Provide subbase material consisting of naturally or artificially graded mixture or natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand that will readily compact to the required density and complying with AASHO M147, Grade A.

3. Grade Control: During construction, maintain lines and grades including crown and cross slope of subbase course.

4. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders or acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12" width of shoulder simultaneously with compacting and rolling of each layer of subbase course.

5. Placing:

a. Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.

b. When a compacted subbase course is shown to be 6" thick or less, place material in a single layer. When shown to be more than 6" thick, place material in equal layers, except no single layer more than 6" or less than 3" in thickness when compacted.

G. Borrow: When the quantity of suitable material required for embankments is not available within the limits of the job site, the contractor shall provide sufficient materials to construct the embankments to the lines, elevations and cross sections as shown on the drawings from borrow areas. The contractor shall obtain from owners of said borrow areas the right to excavate material, shall pay all royalties and other charges involved, and shall pay all expenses in developing the source including the cost of hauling the material.

3.4 GRADING AND DRAINAGE

A. General: Uniformly grade all areas within the limits of site. Smooth finished surface and compact, with uniform levels or slopes between points where elevations are shown. Surfaces shall drain away from buildings and minor surfaces shall be finished. Finish shall be that ordinarily obtainable from either blade grader or hand shovel and rake operations.

B. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/4" when tested with a 10' straightedge.

C. Ditches: Finish ditches to ensure thorough drainage of the subgrade surfaces at all times. Conduct final rolling operations to produce a hard, uniform and smooth cross-section.

D. Grassed Areas: Finish areas to receive grass or sod to within less than 0.10' above or below required subgrade elevations, compacted as specified, and free from irregular surface changes. The degree of finish for grassed areas shall be that ordinarily obtainable from a hand shovel and rake operation.

E. Walks and Driveways: Shape the surface of areas under walks and drives to line, grade and cross section, with the finish surface not more than 0.00' above or 0.10' below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rain.

F. Pavements for Streets and Roads:

1. Shape the surface of the areas under pavement to line, grade and cross section, with the finish surface not more than 1/2" above or below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains.

2. Fill low areas resulting from removal of unsatisfactory soil materials, obstructions, and other deleterious materials, using satisfactory soil material. Shape to line, grade, and cross section as shown on the drawings.

G. Structures and Buildings: All areas shall be shaped to drain away from structures and buildings.

3.5 MAINTENANCE

A. Protection of Graded Areas:

1. Protect newly graded areas from traffic and erosion and keep free of debris.

2. Repair and re-establish grade in eroded and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas: When completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape and compact to the required density prior to further construction. Use hand tamping for re-compaction over underground utilities, if any.

C. Settling: Settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, earth or other finish) and backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition or surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.6 DISPOSAL OF EXCESS AND WASTE MATERIALS

Remove all waste materials, including excavated material classified as unsatisfactory soil material, trash, and debris, from the Owner's property and legally dispose of it.

END OF SECTION 31 2000

SECTION 32 1216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install asphaltic concrete paving and base course as shown on the drawings, as specified herein, and as needed for a complete and proper installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 310000 - Earthwork

B. Section 02514 - Portland Cement Concrete Paving

C. Section 02577 - Roadway and Paving markings

1.3 REFERENCES

A. ASTM D1559 - Resistance to Plastic Flow

B. ASTM D946 - Penetration-Graded Asphalt Cement for Use in Pavement Construction.

C. New Mexico Department of Transportation (NMDOT) Standard Specification for Road and Bridge Construction, latest edition.

D. The Asphalt Institute - Manual MS-4 - The Asphalt Handbook.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with State of New Mexico Department of Transportation Standards for Road & Bridge Construction, Section 401, latest edition.

B. Mixing Plant: Conform to NMDOT Standard Specifications for Road & Bridge Construction, Section 401, latest edition.

C. Obtain materials from same source throughout.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable codes for paving work on public property.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

1.7 SUBMITTALS

A. As specified in the General Conditions and pertinent provisions of Section 01340.

B. Submit proposed mix design for review prior to commencement of work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt Cement: ASTM D946.

B. Aggregate for Wearing Course Mix: NMDOT Standards for Road & Bridge Construction, Section 401, Type II requirements, Class B Sieve Analysis.

C. Aggregate base course: Aggregate base course shall comply with Specification Section 30 of the City of Albuquerque standards of public works construction.

2.2 ASPHALT PAVING MIX

A. Use dry material to avoid foaming. Mix uniformly.

B. Wearing Course: 6.0 percent of asphalt cement by weight with 85-100 percent penetration in mixture in accordance with City of Albuquerque Specification Section 116 for SP-IV design mix. Minimum stability shall be 1800 pounds. Stability & flow shall be determined in accordance with ASTM D1559.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify base conditions under provisions of Section 01400.

B. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 SUBGRADE AND BASE COURSE

A. Compact upper 12" of subgrade and full depth of the base course to 95% per ASTM D-1557.

3.3 PLACING ASPHALT PAVEMENT - WEARING COURSE

A. Place to thickness identified in schedule at end of this Section.

B. Compact pavement by rolling. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

C. Develop rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.4 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from True Elevation: Within 1/2 inch.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400.

B. Samples shall be taken from the asphalt plant and/or laydown surface for testing for each 500 tons or less placed each day. Notify testing representative 48 hours prior to placement of any materials and for required testing of paving subgrade for compaction.

3.6 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury until mixture has cooled and attained its maximum degree of hardness.

B. A seal coat shall be applied to the finished surface of all asphaltic concrete within a period of one month to one year after pavement installation.

3.7 SCHEDULES

A. Pavement shall be placed a total of 4” thickness (2-2” lifts) on 4” aggregate base course over 8" compacted subgrade for all parking areas and the drop-off lanes. Pavement shall be placed a total of 4” thickness on 6” aggregate base course over 12” compacted subgrade for service drive near refuse area and kitchen.

END OF SECTION 321216

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install Portland cement concrete paving as shown on the drawings, as specified herein, and as needed for a complete and proper installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 31000-Earthwork.

1.3 REFERENCES

A. ACI 301 - Specifications for Structural Concrete for Buildings.

B. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

C. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.

D. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

E. ASTM C33 - Concrete Aggregates.

F. ASTM C94 - Ready Mix Concrete.

G. ASTM C150 - Portland Cement

H. ASTM C260 - Air Entraining Admixtures for Concrete.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301.

B. Obtain cementitious materials from same source throughout.

1.5 SUBMITTALS

A. As specified in the General Conditions and pertinent provisions of Section 01300.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable standards for paving work on public property.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen, unless appropriate admixtures have been previously approved.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Form Materials: Conform to ACI 301.

2.2 REINFORCEMENT

A. Reinforcing Steel and Wire Fabric: Type specified in Section 03200.

2.3 CONCRETE MATERIALS

A. Concrete Materials: As specified in Section 03300.

2.4 CONCRETE MIX

A. Mix concrete according to ACI 304. Deliver concrete according to ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301 Method 1.

C. Provide concrete to the following criteria:
1. Compressive Strength: 4000 psi @ 28 days.
2. Slump: 3 to 5 inches.
3. Maximum Aggregate Size: 1 inch.
4. Air Content Range: 4 to 6 percent.
5. Minimum Cement Content: 520 lb./cu. yd. of concrete.

D. Use accelerating admixtures in cold weather only when approved by Architect/Engineer. Use of admixtures will not relax cold weather placement requirements.

E. Use calcium chloride only when approved by Architect/Engineer.

F. Use set retarding admixtures during hot weather only when approved by Architect.

2.5 SOURCE QUALITY CONTROL

A. Provide mix design under provisions of Section 01300.

B. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of work.

C. Test samples in accordance with ACI 301.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of catch basin frames with oil to prevent bond with concrete pavement.

C. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.3 FORMING

A. Place and secure forms to correct location, dimension, and profile.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines and secure to formwork during concrete placement.

3.4 REINFORCEMENT

A. Place reinforcement at mid-height of slabs-on-grade.

B. Interrupt reinforcement at expansion joints.

C. Place reinforcement to achieve pavement and curb alignment as detailed.

D. Provide dowelled joints 18 inches o.c. at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.5 JOINTS

A. Place expansion joints at 24-foot intervals. Align curb, gutter, and sidewalk joints.

B. Place joint filler between paving components and building or other appurtenances. Recess top of filler 1/4 inch for sealant placement by Section 02550.

C. Provide scored joints at 6-foot intervals along sidewalks, between sidewalks and curbs and between curbs and pavement, or as indicated on plans.

3.6 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

C. Place concrete to pattern indicated. Score contraction joints 3/16 inch wide at an optimum time after finishing.

3.7 FINISHING

A. Area Paving: Medium broom.

B. Sidewalk Paving: Medium broom, radiused to 1/2 inch radius, and trowel joint edges.

C. Curbs and Gutters: Medium broom.

D. Inclined Pedestrian Ramps: Heavy Broom perpendicular to slope.

3.8 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Section 01410.

B. Notify testing representative 48 hours prior to placement of any materials and for required testing of paving sub-grade for compaction.

C. Three concrete test cylinders will be taken for up to 75 CY of concrete placed each day.

D. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.

E. One slump test will be taken for each set of test cylinders taken.

F. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.9 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

3.10 SCHEDULES

A. Concrete Sidewalks: 4,000 psi 28 day concrete, 4 inches thick, medium broom finish.

B. Parking Area Pavement and Curbs: 4,000 psi 28 day concrete, 5-1/2 inches thick, medium broom finish.

C. Concrete drive aprons: 4,000 psi 28 day concrete, 6 inches thick, medium broom finish.

END OF SECTION 32 13 13

SECTION 32 3913.21 SURFACE MOUNT METAL BOLLARDS

1.1 SECTION INCLUDES

A. Surface mount metal bollards and mounting accessories.

1.2 RELATED SECTIONS

A. Section 32 1313 - Concrete Paving.

B. Section 32 9000 - Planting.

C. Section 03 3000 - Cast-in-Place Concrete.

D. Section 05 5000 - Metal Fabrications.

E. Section 07 9200 - Joint Fillers

1.3 REFERENCES

A. American International (ASTM):
   1. ASTM A36 – Standard Specification for Carbon Structural Steel.
   2. ASTM A 312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including full range of standard color selections.

C. Shop Drawings: Indicate materials, dimensions, tolerances, welding, fasteners, hardware, mounting, finish, and accessories. Include manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum five years experience in producing site furnishings of the type specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.

B. Do not store products in location with conditions outside manufacturer's absolute limits.

C. Materials delivered to the site shall be examined for concealed damage or defects in shipping. Defects shall be noted and reported to the Owner's Representative in writing.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. Warranty: Manufacturer's standard warranty.
   1. Seller warranties to replace, or at seller's option, repair any product or part thereof which is found to be defective in material or workmanship for a period of one year from date buyer accepts products. All parts and labor required under warranty provisions shall be supplied free of charge.
   2. Transportation costs of returning the products to and from repair facility or costs involved with contractor personnel traveling to buyer's facility for the purpose of repairing products on site shall be borne by seller during 1 year warranty period.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturer: Reliance Foundry Co. Ltd.
   Phone: 604-592-4333 or Toll-Free 888-735-5680
   Fax: 604-590-8875
   Internet: www.reliance-bollards.com or www.bollards.ca
   E-mail: bollards@reliance-foundry.com

B. Subject to compliance with requirements, products of equal performance may be used based on the Architect's review of submittals per Section 01 6300 "Product Substitution Procedures."

2.2 BASIS OF DESIGN

A. Model: Reliance Foundry Model R-7180.
B. Height: 24 inches
C. Diameter: 4 inches outside diameter at body and base.
D. Design: Cylindrical with rounded top.
E. Weight: 14 lbs.
F. Mounting: 2-bolt concealed.
G. Material: Stainless steel, ASTM A312, Grade TP 304.
H. Clear Coat: Water-resistant and anti-graffiti.
H. Installation: Fixed, 2-bolt threaded mount.
I. Provide for removable installation where shown on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates upon which site furnishings will be installed. Verify that surfaces are clean, flat and level within manufacturer's recommended installation tolerances.

B. If preparation is the responsibility of another installer, notify Architect of deviations from manufacturer's recommended installation tolerances and conditions.

C. Do not proceed with installation until substrates have been properly prepared and deviations are corrected.

3.2 INSTALLATION

A. Install bollards in accordance with manufacturer's installation instructions.

B. Install bollards level, plumb, square, accurately aligned, correctly located per drawings, and without warp.

C. Do not install damaged, cracked, chipped, deformed or marred bollards. Field touch-up minor imperfections in accordance with manufacturer’s instructions. Replace bollards that cannot be field repaired.

3.3 CLEANING AND PROTECTION

A. Clean in accordance with manufacturer's recommendations.

B. Protect installed products until completion of project.

C. Touch-up, repair or replace damaged products and finishes in accordance with manufacturer's instructions before Substantial Completion.

END OF SECTION 32 3913.21

SECTION 32 8400 - LANDSCAPE IRRIGATION

PART 1 -GENERAL

1.1 REQUIREMENTS

A. Provide irrigation installation, and warranty as per Drawings and Specifications.

B. All work shall be performed by a landscape contractor experienced with the type and scale of the work required, having materials, equipment, and personnel to perform the work satisfactorily, and having all applicable insurance, licenses, and permits to legally perform that work.

C. Related Documents: Drawings and general provisions of the Contract, 32 8400, and 32 9000 Specification Sections apply to this Section.

1.2 SITE INVESTIGATION AND PROTECTION

A. Contractor shall locate and protect all existing, adjoining utilities and site improvements from damage as a result of his operations. New Mexico One Call System, Inc. (800.321.2537 or local equal, shall be contacted prior to scheduled excavations to verify locations of any existing underground utilities. Contractor shall report to Architect and Owner or his representative conditions which prevent the proper execution of installations.

B. Contractor shall furnish and maintain all warning signs, shoring, barricades, bracing, red lanterns, etc., as required by site regulations and local ordinances.

C. Contractor shall be responsible for repair or replacement of features or conditions damaged through failure to comply with above procedure, at no cost to Owner. All improvements, including repairs and repaving of cut paving shall be performed as part of this contract.

1.3 COORDINATION

A. Contractor shall coordinate and cooperate with other contractors and related work to ensure efficient completion of all work.

1.4 STANDARDS, CODES, AND SAFETY RULES

A. All work and materials shall be installed to meet or exceed the latest industry and manufacturer’s standards of workmanship and quality, including drawings, specifications, and all applicable local and state codes. All work shall be in full accordance with the latest safety rules and regulations.

1.5 SUBSTITUTIONS

A. Any substitutions shall be approved by Architect and Owner prior to installation on the site. Any changes in location of irrigation components shall be effected at no cost to Owner. Rejected materials shall be immediately removed from the site and replaced at Contractor’s expense. Cost of testing materials not meeting the Specifications shall be borne by Contractor.

1.6 INSPECTIONS

A. All coordination between Contractor and Architect and Owner for all inspections / tests shall be initiated by Contractor in advance. Required inspections:

1. Hydrostatic test before backfill of trenches and completed irrigation system
2. Irrigation coverage and standards following completed installation of all plant materials

B. Contractor shall not proceed with work of the next sequence without completing previous work.

1.7 SUBMITTALS

A. SHOP DRAWINGS: Submit one (1) set of shop drawings showing the entire irrigation system, including layout, sizes, and products.

B. MANUFACTURER'S LITERATURE: Submit for approval five (5) sets of manufacturer's literature on all components proposed for usage if they differ from Drawings.

C. RECORD DRAWINGS: At the time of final acceptance, Contractor shall furnish final Record Drawings prepared by a qualified draftsperson showing the entire completed system as actually installed. This is the responsibility of Contractor and is not the responsibility of any other party. Insert a copy into the maintenance manual.

D. VALVE ZONE DIAGRAM: Prepare a waterproof, color-coded diagram keying stations of the controller to valve zones. Diagram shall be mounted inside the door of the automatic controller, and insert an extra copy of that diagram into the maintenance manual.

E. CONTROL KEYS: Provide two (2) keys for all components; insert into the maintenance manual.

F. MAINTENANCE MANUAL: Submit an operation and maintenance manual for the irrigation system in a three-ring notebook. Include the following information:

1. Controller manufacturer's operation / instruction manual
2. List of Contractor recommended operation times for achieving effective plant growth
3. Contractor recommendations for system maintenance

1.8 PROJECT CLOSEOUT

A. SUBSTANTIAL COMPLETION shall be issued when Contractor has completed all work in the contract, and the Architect and Owner has inspected and is satisfied with all work.

B. WARRANTY: Contractor shall guarantee the irrigation system, from issue of substantial completion, through specified maintenance period, until issue of final acceptance.

C. MAINTENANCE: Contractor shall maintain the irrigation system regularly throughout the warranty period defined in these Specifications. Owner shall provide maintenance afterwards.

D. FINAL ACCEPTANCE shall be issued at end of warranty period, and the Architect and Owner has inspected and is satisfied with all work.

PART 2 -PRODUCTS

2.1 IRRIGATION MATERIALS

A. GENERAL

1. All materials throughout the system shall be new as specified on the Drawings, or approved equal.

2. The following components shall be of the manufacturer and size as per Drawings or approved equal and furnished as required to provide a complete operational system:

    a. Backflow Preventor
    b. Zone and Master Valves
    c. Pressure Regulators
    d. Filters: MPT plastic, with 155 mesh and threaded cap
    e. Gate / Ball Valves
    f. Quick-Coupling Valves
    g. Valve Boxes and Extensions
    h. Mainline, Masterline, Lateral Piping, and Sleeving: Conform to ASTM D-1785
    i. Miscellaneous Piping fittings, risers, automatic drain valves, compression fittings, etc.
    j. Rotary and Bubbler Heads
    k. Drip Emitters
    l. Drip Irrigation Distribution Tubing
    m. Steel Pins for Drip Irrigation Tubing
    n. Automatic Controller
    o. Miscellaneous components, including rain sensors, etc.
    p. Solvent cement, cleaners/primers, wire, and wire splicing materials

PART 3 -EXECUTION

3.1 GENERAL

A. Install all irrigation components as per manufacturer's recommendations and local codes, in a neat and competent manner. Some specific procedures or equipment may be absent from these Specifications but must be furnished and installed for necessary operation and function.

B. Material Storage: Contractor shall deliver and stockpile materials outside of all areas to be landscaped and where they shall not interfere with vehicular / pedestrian traffic and other Owner uses.

3.2 INSTALLATION

A. Excavation and Trenching:

1. Contractor shall stake out each piping run, all irrigation heads, and valves prior to trenching to minimize conflicts with the locations of plantings and other elements. Any conflicts with tree and focal planting locations shall be brought to the attention of Architect and Owner before installation.
2. Trench depths shall be sufficient to provide the following minimum grade cover for pipe:

    a. 36” 24 volt wiring
    b. 30" Master / main lines to zone / master valves
    c. 18" Lateral lines to spray / bubbler heads
    d. 4” Polypropylene and vinyl drip irrigation tubing, except at plant end of tubing
    e. 6” additional to above depths for trenching in rocky soil
    f. Slope trenching / piping to valves at a minimum slope of 1’ per 100’.

B. Backfilling:

1. Partial backfilling can begin, leaving all joints and connections exposed for visual inspection during the hydrostatic testing. Only upon completion of successful hydrostatic test can the backfilling operation be completed for any one particular section.
2. All backfill material shall be free from rock, large stones, brush, sod, frozen material or other unsuitable substances that may damage pipe during the backfilling operation.
3. In rocky areas, additional backfill material suitable for this purpose shall be imported and used at the expense of Contractor.
4. Backfill shall be placed in horizontal layers and shall be thoroughly tamped, or water compacted to near original density or so that no settling shall result. Backfill shall be placed to the original grade. If settlement of trenches occurs within one (1) year from the date of completion, it shall be Contractor's responsibility to refill trenches and restore / repair areas to match specified conditions.

C. Other Components:

1. Reduced Pressure Backflow Preventer: Install with locking enclosure and heat tape/wiring as per manufacturer's recommendations and as per local codes. Contractor shall coordinate and make provisions to obtain any necessary electrical supply and connection.
2. Zone / Master Valve: Install each drip zone valve assembly in one separate valve box.
3. Piping and Fitting Assembly:

    a. Install control valves where shown and group where practical; place no closer than twelve (12) inches to paving and wall edges and so proposed plantings screen them.
    b. Plastic piping and fittings shall be solvent welded as recommended by manufacturer of the pipe, except where screwed connections are required. Piping and fittings shall be thoroughly cleaned before applying solvent with a non-synthetic bristle brush.
    c. Solvent Welding Procedure:

        1) PVC plastic piping shall be squarely cut. Wipe burrs with a dry cloth.

        2) Utilizing a cleaner/primer, thoroughly clean the mating pipe end and the fitting socket with a clean, dry cloth.

        3) Apply a uniformly thin coat of solvent cement.

        4) Wipe off any excess solvent cement that forms around the outer shoulder.

        5) Care should be taken so as to not use an excess amount of solvent cement that could cause burrs or obstructions to form on the inside of the pipe joint.

        6) Solvent weld joints shall be allowed to cure for at least 24 hours before pressure is applied to the system.

    d. Make all connections between plastic pipe and metal valves or steel pipe with threaded fittings using plastic male adapters.
    e. Piping shall not be laid or installed when the air temperature is 32° F, or below.
    f. Install Drip Irrigation Lateral Tubing with steel pins every 10 feet, or as necessary to secure tubing from adverse movement. Install as per manufacturer's recommendations.
    g. Closing of Piping / Tubing and Flushing Lines:

1) Cap or plug all openings as soon as lines have been installed to prevent the entrance of foreign materials. Leave in place until removal is necessary for completion of installation.

2) Thoroughly flush out all water lines before installing valves, hydrants, heads, and emitters.

4. Thrust Blocks: Concrete thrust block shall be provided where necessary to resist system pressure. Thrust blocks shall be constructed at all direction changes, size changes, valves, and terminations or at any other points of the system that shall result in an unbalanced thrust line for equipment 2-1/2" and larger. Do not obstruct the outlets of fittings intended for future connections. Thrust blocks shall be poured against undisturbed or compacted earth.
5. Sleeved Crossing: Unless otherwise noted on the Drawings, all piping installed under sidewalks, roadways, parking lots, etc., shall be sleeved in a Class 200 PVC pipe two sizes larger than the pipe to be sleeved, at a depth equal to all piping to be contained within. Wiring shall be placed in a separate sleeve from that of the pipe crossing and shall be 1-1/4" Class 200 PVC. Ends of sleeves shall be sealed with duct tape following installation of wire piping.
6. Rotary / Bubbler Heads:

    a. Install quantities and sizes of heads as per Drawings or as required for specific planting area.
    b. Rotary heads shall be adjusted for optimum coverage of all planting areas they serve.
    c. Bubblers shall be installed at the edges of plant root balls, not at the trunk / main stem of plant materials, to minimize rotting of the plant.

7. Drip Emitters:

    a. Install quantities and sizes of drip emitters as per Drawings or as required for specific planting area.
    b. Drip emitters shall be installed at the edges of plant root balls, not at the trunk / main stem of plant materials, to minimize rotting of the plant.
    c. Install multi-outlet drip emitters on risers with accessories as per Drawings.

8. Automatic Controller:

    a. The controller location is indicated on the Drawings. Contractor shall familiarize himself with the requirements of making the power connections at the locations noted.
    b. For controllers installed inside of buildings, vaults or other enclosures, Contractor shall provide and install on the controller an electrical pigtail outlet and a Tass & Seymour pilot switch and receptacle 15AC1RPL or approved equal.
    c. Remote control valves shall be connected to controller in the numerical sequences as shown on the Drawings or as directed by Architect and Owner.

9. 24-Volt Control Valve Wiring:

    a. Contractor shall install the 24-volt control valve wiring in the same trench as the irrigation mainline. All wires shall be laid below or to one side of piping. In no case shall the wire be laid on top of the pipe. The wires shall be laid loose in the trench and taped together at 10'-0" intervals. When trenches used for piping are not appropriate for routing wire, Contractor shall install wire in a separate trench, 18" deep.

b. Wire splices, other than at valve box locations, shall kept to a minimum, and if needed shall be made only at common splice points and placed in a wire splice box as shown in the detail Drawings. The wire splices shall be made waterproof using Spears Dri-Splice connectors and sealant. At control valve splices, Contractor shall provide a 36" wire expansion coil to facilitate raising splices to ground level without cutting wires.
c. All continual wire shall be one color, with no wire of different colors spliced together.
d. All 24 volt wiring shall be installed in PVC conduit when wiring enters a building.

3.3 HYDROSTATIC TEST

A. Center load piping with backfill to prevent arching or slipping under pressure.

B. Apply a continuous and static water pressure of 100 psi to mainline / 60 psi to lateral lines when welded joints have cured at least 24 hours, with the risers capped, as follows:

1. Mainlines and masterlines shall be tested for one (1) hour; no pressure drop allowed.
2. Lateral lines shall be tested for 15 minutes; maximum pressure drop 3 psi.

C. All air and dirt shall be flushed from the system. Each system valve shall then be opened to apply pressure to the system and each system shall be visually checked for leaks. Any leaks resulting from the test shall be repaired and the system retested until the system passes the test.

3.4 PERFORMANCE STANDARDS

A. After completion of hydrostatic testing and while plantings are being installed, Contractor shall complete installation of the entire system. At completion, adjust irrigation heads for uniform coverage and flow as follows:

1. Pop-up rotary heads: 100% head to head, except in revegetation areas
2. Bubblers and drip emitters: Even, unrestricted flow at each location

B. Contractor shall wire the controller as per manufacturer's recommendations. The valve number shall be indicated on the controller panel for each station. Contractor shall program controller to provide optimum irrigation system performance.

3.5 CLEAN UP

A. Contractor shall keep all work areas and all adjacent paving clean, neat, and orderly at all times. Contractor shall collect and remove all debris from the entire work area prior to inspection for substantial completion by Architect and Owner.

3.6 PROJECT CLOSEOUT

A. SUBSTANTIAL COMPLETION

1. When Contractor is satisfied that the irrigation system is completed and in conformance to the standards listed, they shall request an inspection for substantial completion.
2. Any work deemed not acceptable shall be reworked to the satisfaction of Architect and Owner, at no additional cost to Owner.
3. When the completed work and the Record Drawings have been reviewed and approved by Architect and Owner, a written issue of substantial completion of the project shall be given to Contractor.

B. WARRANTY PERIOD AND REPLACEMENT

1. The irrigation system and all related work shall be functioning properly at the end of the warranty period. Contractor shall guarantee all planting and irrigation system work for a period of one (1) year beginning on the issue date of substantial completion, except as follows:

    a. Contractor shall not be held responsible for the replacement of any irrigation work losses due to causes beyond their control, including vandalism, animals, and/or other destruction caused by others during the maintenance / warranty period. Owner shall incur all such replacement costs.

2. Contractor shall regularly inspect the entire irrigation system, as deemed necessary by the landscape condition. Contractor shall promptly repair, without cost to Owner, all such materials that prove defective in material or workmanship, including line breaks, except for those factors excluded above. Contractor shall replace any irrigation parts as soon as weather conditions permit, during the warranty period. Irrigation parts used for replacement shall be of same kind and size as specified in the Irrigation Legend and previously approved.
3. In the fall, as necessary based on climate, Contractor shall drain the irrigation system and otherwise prepare the system for winter. In the following spring, Contractor shall activate the system, repair any defects or damage and adjust the system. As these services are performed, Contractor shall instruct Owner in the required processes.
4. Contractor shall repair any settlement of trenches by one of the following methods as directed by Owner and Architect.

    a. Bring to grade by top dressing (raking topsoil into the seeded areas).
    b. Bring to grade using topsoil and seed.
    c. Remove existing plants/seed, fill depression with topsoil, and replace with same plants/seed.

C. FINAL INSPECTION / FINAL ACCEPTANCE

1. Contractor shall request final inspection from Architect and Owner.
2. Architect and Owner shall give a written copy of required corrections to Contractor. Any work deemed not acceptable shall be reworked to the satisfaction of Architect and Owner.
3. When all corrected work is completed, a written issue of final acceptance of the project shall be given to Contractor by Architect and Owner.

END OF SECTION 32 8400

SECTION 32 9000 - LANDSCAPE PLANTING

PART 1 -GENERAL

1.1 REQUIREMENTS

A. All work shall be performed by a Contractor experienced with the type and scale of the work required, having materials, equipment and personnel to perform that work satisfactorily, and having all applicable insurance, licenses, and permits to legally perform that work.

1.2 REFERENCE STANDARDS

A. Standards as per Arizona Nursery Grower's Committee "RECOMMENDED AVERAGE TREE SPECIFICATIONS" and "AMERICAN STANDARDS FOR NURSERY STOCK" issued by the American Association of Nurserymen, Washington, D.C. These standards should be considered minimal, unless noted otherwise on the Drawings.

1.3 SITE INVESTIGATION AND PROTECTION

A. Contractor shall locate and protect existing adjoining pavement, curbing, structures, electric cables or conduits, irrigation and utility lines, existing plant materials, and other existing features or conditions above or below ground level that might be damaged as a result of his operations. New Mexico One Call System, Inc. (800.321.2537) or local equal, shall be contacted prior to scheduled excavations to verify locations of any existing underground utilities.

B. Contractor shall furnish and maintain all warning signs, shoring, barricades, bracing, red lanterns, etc., as required by site regulations and local ordinances.

C. Contractor shall be responsible for repair or replacement of features or conditions damaged through failure to comply with above procedure, at no cost to Owner. All improvements, including repairs and repaving of cut paving shall be performed as part of this contract.

1.4 COORDINATION

A. Contractor shall coordinate and schedule with other on-site contractors.

1.5 STANDARDS, CODES, AND SAFETY RULES

A. All work and materials shall be installed to meet or exceed the latest industry and manufacturer standards of workmanship and quality, including drawings, specifications, and all applicable local and state codes. All work shall be in full accordance with the latest safety rules and regulations.

1.6 SUBSTITUTIONS

A. Any substitutions shall be approved by Architect and Owner prior to installation on the site. Any changes in location of plant materials shall be effected at no cost to Owner. Rejected materials shall be immediately removed from the site and replaced at Contractor's expense.

1.7 INSPECTIONS

A. All coordination between Landscape Contractor and Architect and Owner for all inspections / tests shall be initiated by Contractor one week minimum in advance.

B. Rejected plants during any inspection shall be removed immediately, and arrangement to acquire acceptable replacements. Expense for this shall be borne by Contractor.

1.8 SUBMITTALS

A. SHOP DRAWINGS: Submit five (5) sets of shop drawings showing the entire planting and irrigation, including layout, sizes, and products.

B. MANUFACTURER'S LITERATURE: Submit five (5) sets of supplier's literature on all products proposed for usage.

C. RECORD DRAWINGS: At final acceptance, Contractor shall furnish Record Drawings showing the entire, actual completed planting. This is the responsibility of Contractor and is not the responsibility of others. Insert a copy into the maintenance manual.

D. MAINTENANCE MANUAL: Submit an operation and maintenance manual for the plantings. Include the following:

1. Irrigation
2. Fertilization
3. Pruning
4. Pest control
5. Weed control

1.9 PROJECT CLOSEOUT

A. SUBSTANTIAL COMPLETION shall be issued when Contractor has completed all work in accordance with the Contract Documents.

B. WARRANTY: Contractor shall guarantee all plantings, from issue of substantial completion, through specified maintenance period, until issue of final acceptance.

C. MAINTENANCE: Contractor shall maintain the plantings regularly throughout the maintenance period defined in these Specifications.

D. FINAL ACCEPTANCE shall be issued at end of warranty period.

PART 2 -PRODUCTS

2.1 PLANT MATERIALS

A. GENERAL

1. The following items shall be of the species, type, size, and quantity as per Drawings:

a. Trees, Shrubs, and other Woody Plants
b. Accents, Cactus, and other Succulent Plants
c. Perennials, Grasses, Groundcovers, and other Herbaceous Plants; where ground cover planting area is intended, provide in quantity and spacing adequate to fill all such areas as per Drawings
d. Steel Edging
e. Topsoil: fertile loam, high in humus content, free from rocks, sticks, noxious weeds, roots or seeds, toxic amounts of either acid or alkaline chemicals, or other foreign material
f. Organic Soil Amendment.
g. Filter Fabric: Typar or equal
h. Mulch: free of weed seed and compounds detrimental to plant life; free from dirt as is practical for that product. Provide in quantity to fill all areas at depth as per Drawings.

i. Herbicide: liquid preemergants and postemergants
j. Tree Staking: wood poles with wire ties and cotton strapping; no rebar permitted

B. QUALITY

1. All plants shall be sound, healthy specimens typical of their species, with well-formed tops and root systems, free of circling roots. Plants shall be free from broken branches, objectionable disfigurements, injurious pests, diseases, scale, fungus, egg larvae, borers, abrasions, etc. Plants shall be free of invasive weeds or other vegetation. Architect and Owner reserve the right to reject any plants not meeting these criteria, at no cost to Owner. All plants shall be nursery grown, or legally collected with collection tags present.
2. Container Stock shall be grown in its delivery container for more than six months and less than two years. Any improperly rooted or poorly formed plants shall not be accepted.
3. Ball and Burlapped (B & B) Stock: Balls shall be firm and uncracked. Binding shall be of a material that shall withstand transportation. B & B material shall be rejected if wrapped with plastic burlap or plastic twine. All B & B material shall have been properly root pruned.
4. Bare Root Stock: Roots shall be packed in suitable material and kept moist until planted. Material shall show no fresh scars and shall not have been recently pruned.
5. Plants shall conform to measurements of the Planting Legend except as follows:

    a. Plants larger than listed on the Planting Legend may be used, but the use of such plants shall not increase the contract price.
    b. If a given species is unavailable in the size listed on the Planting Legend, Contractor may substitute two plants of the same species. In this case, the next smaller sized container may be used, provided that both plants together are the same size as the original plant. Both plants shall be installed together in the same planting pit. Contractor shall obtain the approval of Architect and Owner prior to making such substitution.
    c. Plants marked in a given container size are to be delivered in containers no less in content than that given container size. Trees in boxes or cans are acceptable if the container is in good condition.

6. Plants shall be free of damaged or topped growth resulting from fit into delivery vehicle.

2.2 SUBSTITUTIONS

A. Substitutions shall not be permitted, except where indicated; or if proof is submitted that any plant specified is not obtainable, a proposal shall be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price.

B. See Planting Legend for specified size, species, and condition of all plants. Quantities given in the Planting Legend are for the convenience of Contractor, only. Total plant symbols shown on the Drawings are the final authority and shall be furnished and installed where shown.

PART 3 -EXECUTION

3.1 GENERAL

A. All plant materials in Drawings shall be handled carefully in accordance with supplier recommendations on loading, unloading, and storage.

B. Installation dates: When ground is not frozen or waterlogged, or during the season of optimum plant growth for each species, as per Drawings.

C. Sequencing / scheduling:

1. Complete subgrade preparation and clearing / grubbing prior to the start of finish grade
2. Finish grade
3. Soil preparation with organic soil amendment
4. Install plants after final grades are established and soil preparation in planting areas is complete. Each installed plant shall be immediately followed with deep, hand watering and any corresponding, functioning irrigation that same workday. No plants shall be installed if those watering and irrigation items cannot be completed.

3.2 CLEARING AND GRUBBING

A. Contractor shall remove all construction debris, miscellaneous piping and irrigation parts, dead or dying plants, and weeds within proposed planting areas, prior to any installations.

3.3 FINISH GRADE

A. Contractor shall provide finish grade, including necessary fill material to establish finish grade, prior to any planting installations. Finish grade is final grade with a smooth, uniform surface ready for planting. Topsoil that matches consistency of existing soil shall be used as fill material. Topsoil in ground cover planting areas shall be at least 6" deep. Finish grade shall be 1" below top of adjacent paved surfaces (3” where mulch is to be used); finish grade in raised planters shall be 2" below top of planter surfaces (4” where mulch is to be used), unless otherwise noted in Drawings.

3.4 SOIL PREPARATION WITH ORGANIC SOIL AMENDMENT

A. After irrigation system installation and finish grade are completed and prior to any plant installations, install organic soil amendment components as per supplier directions.

B. Area of application: entire planting areas, including all associated mulch areas. Top dress each 1000 square feet uniformly with the following amendment components: 5 gallons / .60 cubic feet of Terra Pro, followed by 2-1/2 gallons of Protein Crumblies or approved equal.

C. Thoroughly water in the entire amendment area, immediately following application, until grade is firm and smoothly uniform without eroding, yet loose enough to permit aeration and drainage.

3.5 HANDLING AND STORAGE

A. Lift trees only by methods that shall not damage bark. Lift trees 3” in caliper and larger only with chains triangulated around the root ball.

B. B & B plants shall be dug with firm, natural balls of soil, of a diameter and depth sufficient to encompass fibrous and feeding roots necessary to ensure full recovery and development of plants. No plant shall be planted if the ball is cracked, broken, or dry to the center, except upon special approval. B & B plants shall be lifted using their root ball when they are moved.

C. Container stock shall be handled using the container. Do not remove container-grown stock from containers until planting time.

D. Delivery: Deliver plants after preparations for planting have been completed and install plant immediately. If planting is delayed more than 6 hours after delivery, Contractor shall place plants in shade, protect from weather and mechanical damage, and shall keep all roots moist.

E. Plant roots shall be kept moist at all times, protected from sun and drying winds.

F. Material Storage: Contractor shall deliver and stockpile materials outside of all areas to be landscaped and where they shall not interfere with vehicular / pedestrian traffic and other uses.

3.6 INSTALLATION

A. Plant Placement:

1. Stake / flag all tree locations, or set out all trees.
2. After trees are placed, stake all other plant locations, or set out.
3. Secure approval from Architect and Owner before excavation of pits and planting.

B. Plant Pits and Installation:

1. Install plants in order of size and stature in the landscape, as per the order of listing in "Plant Placement" above, or as directed by Architect and Owner.
2. Till a circular area, three to five times the width of each rootball, with rough sides, gently sloping to a depth equal to root ball height. Heavy soils require the wider size listed. Ground covers, perennials, and herbaceous plants proposed for continuous areas shall have soil tilled for their entire area at a depth to match rootball heights.
3. Excavate individual plant pit within each tilled area to equal rootball width. The soil below each pit shall not be loosened. Fill each pit with water and allow water to soak in completely before installing plants. If water does not drain, install 4" wide soil-filled drainage holes through that caliche / hardpan layer, two (2) minimum, beyond rootball edges.
4. Place plant in pit, so rootball top equals finish grade without backfill. To improve rooting, score rootball sides (4) four times vertically and (2) two times across bottom, ¼" to ½" deep.
5. Gently remove all containers, grow bags, boxes, tape, nursery tags and stakes, and wire after placing in planting pit. Containers shall be removed carefully to avoid breaking the ball. Remove and cut burlap from top and sides of B & B plants. Bare root plants shall have roots spread out and topsoil carefully worked in among them.
6. Compact tilled soil area surrounding each rootball for firmness and so grade equals top of rootball, with the soil firm and flush against entire rootball.
7. Install watering basin immediately outside of each corresponding rootball (excluding ground cover), six (6) inches high, twelve (12) inches thick, with the base equal to finish grade.
8. Unforeseen Obstructions: If rock, large construction debris, or other unforeseen and unsuitable obstructions are encountered in planting excavation, such material shall be removed and sufficient clean, native soil shall be provided as a replacement. The Contractor shall be paid by Owner for necessary operations to properly remedy such conditions at an agreed upon rate, approved by Landscape Architect / Designer.

C. Plant Pit Backfill:

1. Backfill for all planting pits shall be existing native soil, mixed with organic soil amendment as per supplier, except where noted in Drawings. Continually compact backfill using hands and water, as to prevent future soil settlement.

D. Other Components:

1. Topsoil: Install as per Drawings, free of weed seed and compounds detrimental to plant life
2. Filter Fabric: Install as per Drawings, using Typar or equal, installed after plantings
3. Mulch Materials:

a. Plants installed in beds: Install at a uniform depth as per Drawings, pulled 3” minimum away from trunks.
b. Trees installed within turf or meadow areas: Install in same manner as in adjacent beds at a uniform depth, covering entire plant pit and pulled back from trunk.

4. Herbicide: Liquid preemergants and postemergants, only. Apply as per manufacturer instructions, Drawings, and as needed. No preemergants shall be applied in seeded areas.
5. Tree Staking: Install two (2) wood poles through plant pit into undisturbed soil as per Drawings or as necessary due to wind throw; no rebar shall be permitted.
6. Pruning: Contractor shall prune plants after planting is complete. All trees shall be trimmed to a maximum of one-fourth total branch volume or quantity. All sucker or unsightly growth shall be removed at this time. Other plants shall receive pruning for dead wood, only. This shall be done only in accordance with good horticultural practice, preapproved by Architect and Owner.

3.7 PERFORMANCE STANDARDS

A. At completion of landscape planting installations, all plants shall have live, flexible foliage and / or stems, and be healthy and uniformly growing as is typical and practical for their species, including the season. Mulch materials, staking, and all other components related to planting shall be firm, with a finished appearance.

3.8 CLEAN UP

A. Contractor shall keep all work areas and all adjacent paving clean, neat, and orderly at all times. Contractor shall collect and remove all debris from the entire work area prior to inspection for substantial completion.

3.9 PROJECT CLOSEOUT

A. SUBSTANTIAL COMPLETION

1. When Contractor has completed all landscape planting work in conformance to the standards listed, they shall request an inspection for substantial completion.
2. Any work deemed not acceptable shall be reworked to the satisfaction of Architect and Owner, at no additional cost to Owner.
3. When the completed work and the Record Drawings have been reviewed and approved by Architect and Owner, a written issue of substantial completion of the project shall be given to Contractor.

B. WARRANTY PERIOD AND REPLACEMENT

1. All plants shall be alive and growing properly, with all related work, such as irrigation, functioning properly, at the end of the warranty period. Contractor shall guarantee all planting work for a period of one (1) year beginning on the issue date of substantial completion, except as follows:

    a. Contractor shall not be held responsible for the replacement of any planting work losses due to causes beyond their control, including vandalism, animals, inappropriate planting times as directed by others, lack of dedicated irrigation, and/or other destruction caused by others during the maintenance / warranty period.

2. Contractor shall regularly inspect all planting areas, and as approved or directed by Architect and Owner. Contractor shall promptly replace, without cost to Owner, all plants or materials

that prove unhealthy, dead, or defective in material or workmanship, except for those factors excluded above. Contractor shall replace any plants or materials as soon as weather conditions permit, during the warranty period. Plants and other materials used for replacement shall be of same kind and size as specified in the Drawings and previously approved.

3. Contractor shall repair any settlement of planting areas by one or both of the following methods as directed by Architect and Owner:

    a. Bring to grade by top dressing and/or topsoil.
    b. Replacement with new plants matching the original size of the former plants.

C. MAINTENANCE

1. Refer to and follow section 32 0190, Landscape Maintenance specifications.

D. FINAL INSPECTION / FINAL ACCEPTANCE

1. Contractor shall request this inspection from Architect and Owner.
2. Architect and Owner shall give a written copy of required corrections to Contractor. Any work deemed not acceptable shall be reworked to the satisfaction of Architect and Owner.
3. When all corrected work is completed, a written issue of final acceptance of the project shall be given to Contractor by Architect and Owner.

END OF SECTION 32 9000

SECTION 33 4000 - STORM SEWER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplemental General Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Extent of storm sewer collection system work is shown on drawings. Storm sewer collection system work includes, but is not limited to, the following:

1. Trench drains
2. Private storm drainage piping
3. Storm drain inlet frames and gratings

B. Concrete shall be per NMDOT Standard Specification.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings for piping, fittings, trench drains, and area drain frames and covers.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. General: Furnish ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions and end caps of same type and class of material as conduit, or of material having equal or superior physical and chemical properties as acceptable to the Architect.

B. Polyvinyl Chloride Pipe: ANSI/ASTM D 3034, Type PSM. Pipe shall have a minimum SDR of 35.

2.2 METAL ACCESSORIES

A. Area Drain Frames and Covers: Cast iron manhole frame and cover castings shall conform to ASTM A 48, Class 25C. The bearing surfaces of the frames and covers shall be ground and the cover shall seat firmly onto the frame without rocking. Tapered edges will not be acceptable. Frames and covers shall be as detailed on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION OF SEWER PIPE

A. General:

1. The interior of the pipe shall be thoroughly cleaned of foreign material before being placed in the trench and shall be kept clean during construction hours. When work isn't in progress, the open ends of the pipe shall be securely closed so that no foreign materials will enter the pipe.

2. The Contractor shall install a plug in the new storm sewer at any point of connection to an existing system. The plug shall remain in place until the Inspector authorizes its removal in writing. The Contractor shall not flush or otherwise discharge any flow into an existing system unless approved in writing by the Architect/ Engineer.

3. Pipe shall be laid to line and grade as shown on the plans and as staked in the field. The bedding of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe barrel. Suitable excavation shall be made to receive the bell of the pipe and the joint shall not bear upon the trench bottom. All adjustments to line and grade shall be made by scraping away or filling with pipe zone material under the body of the pipe, and not by wedging or blocking. When connections are made to an existing manhole, pipe, or other improvement, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for and expose the existing improvement before laying the connecting pipe or conduit.

4. Pipe shall be laid upgrade in a continuous operation from structure to structure, with the socket or collar ends of the pipe upgrade unless otherwise permitted by the Architect/Engineer.

B. Plastic Pipe:

1. Plastic sewer pipe shall be connected and placed in the trench in accordance with the manufacturer's recommendations. For plastic pipe connection to catch basins, core drill the existing concrete and use non-shrink non-metallic grout to fill annular space per City Standard Drawing No. 2237.

C. Final Clean Up: No rocks, dirt, joint compounds, cement mortar and other trash or obstructions shall be left in a storm sewer pipe of any size or type. During the flushing operations the downstream catch basin shall be bagged or plugged so that this debris will not be carried into or contaminate an existing or active line.

END OF SECTION 33 40 00