

PROJECT MANUAL – VOLUME 2 OF 2



Jarrell Middle School Additions

Jarrell Independent School District

Jarrell, Texas



MORE THAN ARCHITECTS

PROJECT MANUAL

Project Name: Jarrell Middle School Additions

Client Name: Jarrell Independent School District

Location: Jarrell, Texas

Project Number: 1756-02-01

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SECTION 21 00 10

BASIC FIRE PROTECTION SYSTEM REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 21, apply to this Section.

1.2 SECTION INCLUDES

- A. Basic fire protection requirements necessary to provide complete installation of all Division 21 work.

1.3 WORK INCLUDED

- A. This section of work comprises furnishing of all materials, equipment, tools, scaffolding, rigging, hoisting, labor and transportation necessary for the complete installation of the fire protection system as shown on the plans and as specified herein.
- B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Architectural, Structural, Plumbing, Heating, Ventilating, Air Conditioning and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.

1.4 RELATED SECTIONS

- A. The conditions of the Division 1 requirements and the contract requirements which include the General Conditions and the Supplementary Conditions apply to the work of this division.

1.5 CODES & REFERENCE STANDARDS

- A. General:
 - 1. Perform all Division 21 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.
 - 2. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes.
 - 3. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.
 - 4. The date of the code or standard that is in effect on the date of issue of the contract documents except when a particular publication date is specified.
 - 5. The Contractor shall be held responsible for verifying all local codes and ordinances that may alter any part of the plans or specifications. The Contractor shall bear all costs for correcting the deficiencies.

6. Where local codes and ordinances are not in writing or on record but a local precedence has been set, the Owner shall pay for any additional cost incurred.
- B. Applicable Codes and Standards for All Division 21 Work:
 1. International Building Code
 2. International Gas Code
 3. International Plumbing Code
 4. International Mechanical Code
 5. International Energy Conservation Code
- C. National Electrical Code
- D. Occupational Safety and Health Administration Standards:
 1. OSHA Standard 2207 - Construction Industry Standards
 2. OSHA 29 CFR Part 1926 – Regulation of Excavation
 3. Texas Underground Facility Damage Prevention Act (H.B. 2295)
 4. All other applicable standards
- E. National Fire Protection Association
- F. Fire Sprinkler System:
 1. NFPA 13
 2. NFPA 14
 3. NFPA Life Safety Code 101 Section 8-3
 4. All other applicable codes
- G. National Appliance Energy Conservation Act of 1987
- H. Texas State Board of Insurance Standards
- I. Clean Air Act and Clean Air Act Amendments of 1990
- J. Safety Code for Elevators and Escalators
- K. State Codes:
 1. Texas Department of Labor Boiler Rules and Regulations
 2. All other applicable codes
- L. Local Municipal Codes and Ordinances

1.6 SCHEDULE OF ABBREVIATIONS

- A. Reference Standards are listed in Section 21 using abbreviations listed below:

AABC	Associated Air Balance Council
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADC	Air Diffusion Council
AGA	American Gas Association
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWE	American Welding Society

AWWA	American Water Works Association
CGA	Compressed Gas Association
CISPI	Cast Iron Soil Pipe Institute
CS	Commercial Standard
CSA	Canadian Standards Association
DIPRA	Ductile Iron Pipe Research Association
DOT	Department of Transportation
DOC	Department of Commerce
FCC	Federal Communications Commission
FM	Factory Mutual
FS	Federal Specification
IBC	International Building Code
ITL	Independent Testing Laboratories
NEC	National Electric Code
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning National Association
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health
TWC	Texas Water Commission
UL	Underwriters Laboratories

1.7 QUALITY ASSURANCE

- A. Provide complete installations of all systems.
- B. Furnish all items of equipment, material, and labor to complete the Contract even though each and every item necessary is not specifically mentioned or shown.
- C. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern.
- D. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.
- E. All fire sprinkler equipment and sprinkler heads shall be the same brand.
- F. Contractor's Responsibility
 1. Erect barricades, protective fencing, and signs to prevent injury to personnel on site.
 2. Make permanent connection to utilities or existing lines. Determine depth and location, and bid accordingly.
 3. Relocate and repair any existing lines cut by general construction work.
 4. Pay all costs in connection with double check detector assembly.
 5. Plans do not show exact location and elevations of lines, nor do they show all offsets required.
 6. Deviate from plans as required to conform to the general construction and provide proper grading.
 7. Maintain all utility services during construction to existing portions of job that remain.
 8. Procure and pay for all necessary permits or licenses to carry out the work.
 9. Obtain and pay for all the necessary certificates of approval which must be delivered to the Architect before final acceptance of the work.
 10. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.

11. Protect work from damage by other trades.
12. Make all tests required by law; pay all costs in connection with the testing.
13. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.
14. Provide controls, relays, all low-voltage wiring, conduit and wiring related to fire sprinkler system, and other equipment and devices to form a complete working system.

1.8 DEFINITIONS

- A. Approval:
 1. It is understood that approval must be obtained from the Architect in writing before proceeding with the proposed work.
 2. Approval by the Architect of any changes, submitted by the Contractor will be considered as general only to aid the Contractor in expediting his work.
 3. Contractor:
 - a. The Contractor engaged to execute the work included in a particular section only, even though he may be technically described as a Subcontractor to the General Contractor.
 - b. If the Contractor engaged to execute said work employs Sub-Contractors to perform various portions of the work included under this Section, he shall be held responsible for the execution of same, in full conformity with Contract Document requirements.
 - c. The Contractor shall cooperate at all times and shall be responsible for the satisfactory cooperation of his Subcontractors with the other Contractors on the job so that all of the various phases of the work may be properly coordinated without unnecessary delays or damage to any parts of the work of any Contractor.
 4. Provide:
 - a. Defined as requiring the furnishing and installing of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

1.9 WARRANTY

- A. The Contractor shall warranty his work against defective materials and workmanship for a period of one year from date of acceptance of the job.
- B. Neither the final payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.
- C. He shall remedy any defects due thereto, and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from date of substantial completion.
- D. The Owner shall give notice of observed defects with reasonable promptness.
- E. This Guarantee shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.10 SITE VISIT

- A. Before submitting his proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required.
- B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.11 SUBMITTALS

A. Submittal Procedures:

1. Bidding requirements, contract forms, conditions of the contract, Division 1 - General Requirements and Division 21 apply to work of this division, in addition to the following:
 - a. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the Architect, Engineer and Owner.
 - b. Where specified materials, process, or methods of construction or manufactured article is specified by name or by reference to the catalog number of a manufacturer, the specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings.
 - c. In all cases, the Contractor shall verify the duty and available electric characteristics with the specific characteristics of the equipment offered for review. All component parts of each item of equipment or device shall bear the manufacturer's name plate giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc., in order to facilitate maintenance or replacement.
 - d. Unapproved Products: If materials or equipment are installed before being reviewed and approved by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of unapproved materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.
 - e. This Contractor shall call to the attention of the Architect/Engineer by letter or on shop drawing submittals, any instance in which the shop drawings differ from the requirements of the Drawings and Specifications.
 - f. Data and shop drawings shall be coordinated and included in a single submission. Multiple submissions are not acceptable except where prior approval has been obtained from the Architect/Engineer. In such cases, a list of data to be submitted later shall be included with the first submission. Failure to submit shop drawings that meet the requirements of the Drawings and Specifications in ample time for review shall not entitle the Contractor to an extension of contract time, and no claim for extension by reason of such default shall be allowed.
 - g. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink. Data of a general nature shall not be acceptable. Data and shop drawings shall be identified in accordance with Division 01. In addition, shop drawings shall be identified by the name of the item and system and the applicable Specification paragraph number.
 - h. Electronic Submittals: Electronic submittal requirements will be determined by the Architect. If this method is required then the procedures described in this section shall be modified as follows:
 - (1) The contractor shall supply only one copy of the submittal, rather than the six copies described in this section. The submittal shall be accompanied by a letter stating that the contractor desires the response in electronic form, and that prior approval for this method has been granted.
 - (2) After reviewing the submittal, the engineer will create electronic files from the reviewed submittal material.
 - (3) The electronic files will either be mailed to the architect, or posted to a web site, depending on the architect's requirements. The architect and contractor can distribute copies of the files as desired.
 - (4) The engineer will retain the paper copy of the submittal as a file copy.

- B. Product Data:
 - 1. Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink or highlighting. Data of a general nature shall not be acceptable.
- C. Coordination Correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the initial submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication, whether by mail, fax, or e-mail, will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the initial submittal package along with a copy of the correspondence.

1.12 PROJECT RECORD DOCUMENTS

- A. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building.
- B. Upon submitting his request for final payment, he shall turn over to the Architect/Engineer, for subsequent transmittal to the Owner, a clean, neatly marked set of reproducible plans showing "as installed" work and an electronic file with changes of materials.
- C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication (2 each), prepared in 3 ring binders of sufficient size, black in color, neat in appearance, and turned over to the Architect/Engineer for checking and subsequent delivery to the Owner:
 - 1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
 - 2. Approved fixture brochures.
 - 3. Copies of approved shop drawings.
 - 4. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
 - 5. Any and all other data and/or plans required during construction.
 - 6. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.
- D. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
 - 1. General Contractor and all sub-contractors.
 - 2. Major Equipment Suppliers.

1.13 TRAINING

- A. Upon completion of the work and at a time designated by the Owner's representative, provide a formal training session for the Owner's operating personnel to include location, operation, and maintenance of all fire protection equipment and systems, some sections have further instructions.
- B. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Owner's representative.

- C. At the conclusion of the instruction, obtain the signatures of the attendees on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Owner's representative and Engineer as a condition of final acceptance.

1.14 PLANS AND SPECIFICATIONS

- A. The plans show diagrammatically the locations of the various lines, ducts, conduits, fixtures, and equipment and the method of connecting and controlling them.
- B. It is not intended to show every connection in detail and all fittings required for a complete system.
- C. The systems shall include but are not limited to the items shown on the plans.
- D. Exact locations of these items shall be determined by reference to the general plans and measurements of the building and in cooperation with other contractors, and in all cases, shall be subject to the approval of the Architect/Engineer.
- E. The Architect/Engineer reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.
- F. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.15 UTILITIES, LOCATIONS, AND ELEVATIONS

- A. Locations and elevations of the various utilities within the scope of this work have been obtained from the City and/or other substantially reliable sources and are offered separately from the Contract documents, as a general guide only, without guarantees as to accuracy.
- B. The Contractor shall examine the site, shall verify to his own satisfaction the locations, elevations and availability of all utilities and services required, and shall adequately inform himself as to their relation to the work; the submission of bids shall be deemed evidence thereof.
- C. The Contractor shall coordinate all services with the Utility Companies during construction, coordinate changes made by Utility Companies to the design of project, and coordinate with the Owner, Architect/Engineer, and Utility the scheduling of any shutdowns or delays that may occur in providing service.
- D. The Contractor shall verify location, conduct all necessary tests, inspections, coordinate with Owner's representatives and utilities, and check for existing underground utilities and lines before ditching.
- E. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.

1.16 SUBSTITUTION OF PRODUCTS

- A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.

- B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.
- C. The Engineer will consider all such submittals and the Architect will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.
- D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.
- E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.
- F. Requests for substitution are understood to mean that the Contractor:
 - 1. Has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - 2. Will provide the same guarantee for the substitution that he would for that specified.
 - 3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.
- G. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances:
 - 1. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
 - 2. The specified product is unavailable through no fault of the Contractor.
 - 3. The manufacturer refuses to warranty the specified products as required.
 - 4. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
 - 5. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.
- H. Revisions to the fire protection system shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.17 PROTECTION OF EQUIPMENT AND MATERIALS

- A. The Contractor shall take such precautions as may be necessary to properly protect his apparatus from damage.
- B. This shall include the creation of all required temporary shelters to adequately protect any apparatus above the floor of the construction and the covering of apparatus in the completed building with tarpaulins or other protective covering.
- C. Failure to comply with the above to the satisfaction of the Owner's inspector will be sufficient cause for the rejection of the equipment in question and its complete replacement by this Contractor.
- D. All apparatus shall be cribbed up from the floor or ground by the Contractor and covered with tarpaulins or other protective covering where necessary or directed.

1.18 FINAL INSPECTION

- A. It shall be the duty of this Contractor to make a careful inspection trip of the entire project, assuring himself that the work on the project is ready for final acceptance before calling upon the Architect/Engineer to make a final inspection.
- B. To avoid delay of final acceptance of the work, the Contractor shall have all necessary bonds, warranties, receipts, affidavits, etc., called for in the various articles of these specifications, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and shall deliver the same to the Architect/Engineer at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc., before preparing for submission to verify that the terms check with the requirements of the specifications.

1.19 ASBESTOS

- A. No asbestos or asbestos containing materials shall be permitted in this project.

1.20 CUTTING AND PATCHING

- A. All Subcontractors shall notify the General Contractor sufficiently ahead of construction of any floors, walls, ceiling, roof, etc., of any openings that will be required for his work.
- B. He shall see that all sleeves required for his work are set at proper times so as to avoid delay of the job.
- C. All necessary cutting of walls, floors, partitions, ceilings, etc., as required for the proper installation of the work under this Contract shall be done at the Subcontractor's expense in a neat and workmanlike manner, and as approved by the Architect/Engineer.
- D. No joists, beams, girders or columns shall be cut by any Contractor without first obtaining written permission of the Architect/Engineer.
- E. Patching of openings and/or alterations shall be provided by the General Contractor.
- F. All openings in firewalls and floors, such as thimbles, shall be completely sealed after installation for a completely airtight installation. Sealing material shall be non-combustible and UL approved. The installed sealing assembly shall not cause the fire rating of the penetrated structure to be decreased.
- G. All openings in exterior walls shall be sealed watertight.

1.21 IDENTIFICATION

- A. Refer to Section 22 05 54.

1.22 MANUFACTURER'S INSTRUCTIONS

- A. All equipment and devices shall be installed in accordance with these plans and specifications, manufacturer's instructions and applicable codes.
- B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions.

- C. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.23 RELATED WORK

- A. The various specification sections for this division may or may not include related work listings.
- B. All related work shall be coordinated and provided by the Fire Protection Contractor regardless whether specifically identified or not.

1.24 ELECTRICAL WIRING AND EQUIPMENT FOR FIRE PROTECTION SYSTEMS (FIRE PUMPS)

- A. All wiring, conduit, boxes, equipment (controls, relays, contactors, motor starters, heaters, switches) and any other control devices or equipment required to form a complete and properly operating system, shall be the responsibility of this Contractor.
- B. The Electrical Contractor shall only provide line voltage (including hook-up) to all fire protection equipment.
- C. All fire protection controls and devices shall be low voltage unless otherwise noted or shown on the plans. Where line voltage controls or devices are noted, the Contractor shall provide complete wiring diagrams (approved by the Engineer) to the Electrical Contractor prior to final hook-up.
- D. The Fire Protection and Electrical plans are based on a performance specification and preliminary flow test. Should any fire protection equipment or device be changed or approved from those which are shown or noted, all electrical and/or fire protection changes shall be made at the expense of the trade or contractor initiating the change with no expense to the Owner, Architect, Engineer or their representatives.
- E. All wiring provided by this Contractor shall be installed in a workmanlike manner using tie wraps, labels, anchors and etc. Loose wiring is not acceptable. All wiring in exposed areas shall be installed in conduits.
- F. All conduit and boxes required in all walls for control purposes shall be provided by electrical contractor. All conduit required in attic, clear spaces, or on roof shall be by mechanical contractor.

1.25 DEMOLITION AND REMODEL

- A. It shall be the responsibility of this Contractor to see that all demolition and remodeling work involving his trade (including but not limited to fire sprinkler piping, control air piping, fire protection equipment, etc.) is accomplished in a manner and completeness to provide the appearance of new construction work.
- B. Any usable equipment and/or structure damaged during demolition and remodel work shall be replaced.
- C. All abandoned and/or otherwise unused piping shall be securely capped using materials of the same composition as the original piping.
- D. No exposed piping and/or other materials will be permitted in the finished job.
- E. Any abandoned piping which penetrates the slab in an exposed area shall be securely capped below the slab.

1.26 OPERATION PRIOR TO COMPLETION

- A. When any piece of fire protection equipment is operable and the Contractor needs to operate the equipment, he may do so providing that he properly supervises the operation.
- B. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner.
- C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all punch list items before final acceptance by the Owner.
- D. The date of acceptance and the start of the warranty may not be the same date.

1.27 SAFETY GUARDS

- A. Contractor shall furnish and install all safety guards required. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

1.28 FLAME SPREAD PROPERTIES OF MATERIALS

- A. All materials and adhesives used in fire sprinkler system shall conform to NFPA and UL life and flame spread properties of materials.
- B. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating as listed for the basic material, the finishes, adhesives, etc., specified for each system and shall be such when completely assembled.

1.29 LEAD MATERIALS

- A. No lead or lead containing materials shall be allowed in any domestic or potable water supply piping, valves, fixtures, components, equipment or any other item.

1.30 ACCESS CLEARANCE

- A. Proper access to all installed equipment shall be provided. The Fire Sprinkler Contractor shall label all points of access immediately upon installation with a marker pen.
- B. This contractor is responsible for providing coordinated clearances with all other trades.
- C. If another trade violates this space, the General Contractor shall be notified immediately.

PART 2 PRODUCTS

- A. Not Applicable

PART 3 EXECUTION

3.1 TESTING

- A. After the fire protection system has been completed and put into operation, subject system to an operating test under design conditions to check for system leaks.

- B. Make adjustments as required to ensure proper functioning of all systems.
- C. Special tests on individual systems are specified under individual sections.
- D. Obtain all state and city permits and approvals.

END OF SECTION

SECTION 21 13 14

FIRE PROTECTION SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 21 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Furnish and install complete fire protection system, as described, including all piping, heads, hangers, fittings, valves, devices and components whether specifically specified or not. Keep existing system operational during construction.

1.3 RELATED SECTIONS

- A. Section 21 00 10 - Basic Fire Protection System Requirements
- B. Section 22 05 24 - Valves - General
- C. Section 22 05 30 - Pipe and Pipe Fittings - General
- D. Section 22 33 34 - Access Doors
- E. Section 28 46 21 - Fire Detection and Alarm System

1.4 REFERENCES

- A. NFPA 10 - Fire Extinguisher Cabinet
- B. NFPA 13 - Sprinkler System
- C. NFPA 20 - Fire Pumps
- D. NFPA 24 - Underground Mains
- E. NFPA 1961 - Fire Hose
- F. NFPA 1963 - Fire Hose Connections
- G. NFPA 1964 - Spray Nozzles
- H. UL 2443 – Standard for Flexible Sprinkler Hose
- I. UL - Underwriter Laboratory
- J. FM - Factory Mutual
- K. State Fire Marshall's Office
- L. Insurance Services Office

- M. ASTM C-150 - Pipe and Fittings
- N. ASTM A-53 - Steel Pipe Black and Hot-Dipped, Zinc Coated, Welded and Seamless
- O. ASTM A-795 - Black and Hot Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe For Fire Protection Use
- P. AWWA C-502 - Dry-Barrel Fire Hydrants

1.5 WORK REQUIRED

- A. Furnish and install a complete automatic wet pipe fire protection sprinkler system including all materials, labor, equipment, appurtenances and accessories necessary for, or incidental to, the execution of a complete sprinkler and fire line/fire hydrant system. This system shall include all necessary freeze protection as required to meet NFPA requirements.
- B. Furnish and install a complete automatic dry pipe fire protection sprinkler system including all materials, labor, equipment, appurtenances and accessories necessary or incidental to the execution of a complete sprinkler and fire line/fire hydrant system.
- C. Provide a dry zone to serve all canopies.
- D. The work shall include the connection of the City main, risers, double check detector assembly, alarm checks, fire department connections, all exterior water piping, ditching, pavement patching, all interior piping, heads, hanger, unions, fittings, alarm valves, approved OS&Y valves, air compressors, valves, escutcheons, flow switch for fire alarm connections, etc. for a complete turnkey job.
- E. The Contractor shall coordinate with the City regarding the requirements and layout of the vault for the detector check, double check and any by-pass valves.
- F. The work shall include all freeze protection as required in accordance with NFPA.
- G. This is a Performance Specification to meet the requirements of authorities listed in Section 21 00 10. The drawings are prepared as diagrammatic and are drawn for coordination with the mechanical, electrical and other trades. They are suggested arrangements only. The Fire Protection Contractor shall coordinate the installation of all items of the fire protection system with all other trades, so that all components will be installed to avoid conflict. Components improperly installed shall be removed and/or relocated as directed by Architect or Engineer at no additional cost.
- H. Become thoroughly familiar with the construction details illustrated on the drawings before submitting your bid as no allowance will be made because of the Contractor's unfamiliarity with these details.
- I. Construction and installation drawings shall be prepared according to standard practice. Changes from these drawings necessary to accomplish the work of the various trades or to conform to the rules of authorities having jurisdiction shall be made without additional cost to the Owner.
- J. Exact final location of all exposed mechanical piping, equipment, etc. shall be verified with the Architect.

1.6 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 21 00 10, General Conditions, and Division 1.
- B. Sprinkler Contractor to provide building shop drawings to Mechanical, Electrical and Plumbing Contractors for coordination.
- C. Submit fully-dimensioned shop drawings in accordance with general conditions. Densities and spacing as required by NFPA 13 and City Fire Department.
- D. All piping on shop drawing to be labeled with pipe elevation above finished floor.
- E. The system shall be a hydraulically calculated system for the hazard categories, and hydraulic calculations shall be submitted.
- F. Shop Drawings to show piping, materials, heads, pipe elevations, pipe hangers, fittings, appurtenances, hydraulic calculation, etc. Show all details as required by NFPA 13.
- G. Submit and obtain approval from the local approving authority before submission to the Architect.
- H. Submit data books showing sprinkler heads, alarm valves, pipe, fittings, hangers, switches, and other specialty items for review and approval.
- I. Provide “as built” drawings at the end of project with disk using PDF files.

1.7 QUALITY ASSURANCE

- A. Sprinkler Contractor to be licensed and have a minimum of 3 years’ experience installing fire protection systems.
- B. All piping shall be new materials.
- C. All products meet U.L. or F.M. and display labels.
- D. Conform to NFPA #10, #13, #20 and #24.
- E. Meet or exceed State Fire Marshall's Office and Insurance Services Office.
- F. Meet or exceed all local codes.

PART 2 PRODUCTS

2.1 CONNECTION TO CITY MAIN

- A. Provide connection to City water main as shown on drawings from the connection to and including the point inside the building above ground. Sprinkler Contractor to obtain up to date water flow test to verify sprinkler system will work in accordance with NFPA 24.
- B. This work shall include the connection to the existing main, all exterior water piping, ditching, pavement patching, fittings, valves, etc.

- C. Piping:
 - 1. Ductile Iron Pipe and Fittings:
 - a. Class 150 per AWWA C-150-76 specification.
 - 2. PVC Pipe and Fittings:
 - a. C900 PVC Class 150
 - b. Use PVC for underground piping 5'-0" from building if approved by code.
 - 3. Thrust Blocks:
 - a. Constructed of 2,500 psi concrete.
 - b. Provide at all changes in direction in the fire line piping.

2.2 SPRINKLER PIPING ABOVE GROUND

- A. Type:
 - 1. Black steel per ASTM A53 or ASTM A795.
- B. Wall Thickness and Joining System:
 - 1. Per NFPA 13 requirements.
- C. Sleeves:
 - 1. Above Grade:
 - a. Galvanized steel.
 - 2. Below Grade:
 - a. Cast iron.
- D. Hangers:
 - 1. Per NFPA 13 requirements
- E. Fittings:
 - 1. Screwed fittings to be 125 lb. cast iron.
 - 2. Grooved fittings and couplings to be Victaulic or equal.
 - 3. Welded outlets may be used.
 - 4. Any other joining system requires prior approval.

2.3 VALVES

- A. Acceptable Manufacturers:
 - 1. Nibco
 - 2. Victaulic
 - 3. Ames
 - 4. Milwaukee
- B. Backflow Preventers:
 - 1. Ames 2000SS, or as approved by local municipalities.
 - 2. B.F.P. must be certified by approved testing personnel and testing report submitted for Owner's records.
- C. Control Valves:
 - 1. Grooved butterfly valves only
 - 2. Manufacturers:
 - a. Victaulic
 - b. Milwaukee
 - c. NIBCO
 - 3. The use of O.S.& Y. valves to be avoided if possible.
- D. Check Valves:
 - 1. To be grooved type for appropriate pressures.

- E. Inspector's Test Connections:
 - 1. AGF or Victaulic one handle type complete unit that allows testing and draining.
- F. Alarm Valves:
 - 1. Acceptable manufacturers:
 - a. Reliable or TYCO
 - b. Valves to be pre-trimmed grooved type if possible complete with variable pressure trim and retard chamber are required.
- G. Dry Valves:
 - 1. Acceptable Manufacturers:
 - a. Reliable or TYCO
 - b. Valves to be pre-trimmed grooved type if possible and include all necessary pressure switches as required.

2.4 PIPING

- A. Exterior Piping:
 - 1. Exterior underground piping shall be domestic made C900 or Blue Brute with ductile iron mechanical joint fittings. All joints to be rodded and thrust blocked per NFPA 24 requirements. All exposed support materials to be made of stainless steel to prevent corrosion.
 - 2. The 5'-0" stub out piece of underground fireline to be a stainless steel in building riser made as one piece. This is to be installed per NFPA 24.
- B. Interior Piping:
 - 1. Piping to meet the ASTM requirements for welded steel piping. The sprinkler mains to be Schedule 10 black piping joined with grooved fittings. The branchline piping to be SCD 40 black piping joined with threaded cast iron fittings. Piping and fittings are to be UL listed. No mixing of black and galvanized piping.
 - 2. Piping for dry systems if any are required to be black with same scheduling and joining process as listed above for the wet systems.

2.5 FLEXIBLE SPRINKLER HOSE FITTINGS

- A. Manufacturer
 - 1. Flex Head or equal
- B. Product: Hose fittings are to be:
 - 1. FM approved,
 - 2. Compliance with UL 2443,
 - 3. 100% type 304 stainless steel, pressure tested in accordance to meet all NFPA standards.
 - 4. Fully welded non-mechanical fittings, braided or corrugated and leak tested.

2.6 FITTINGS AND COUPLINGS

- A. Acceptable Manufacturers:
 - 1. Victaulic
 - 2. Anvil
 - 3. Star
 - 4. Tx Line
 - 5. All fittings must be U.L. listed and FM approved for use in fire sprinkler systems and be from the same manufacturer.

- B. No mixing of black and galvanized fittings allowed.

2.7 HANGERS AND SUPPORTS

- A. All hangers and supporting materials to be per NFPA and code requirements.
- B. All hanger attachments on steel beams and bar joists are to be attached at the top of the beam or joist. No attachments to bottom of steel structure or wind bracing.
- C. All thread rod to be plated type to prevent corrosion.
- D. Trapeze material to be per NFPA 13 requirements.

2.8 FIRE VALVES

- A. Type:
 - 1. Standard 2½ inch fire department valves with caps and chains mounted in valve cabinets where required by NFPA and/or Local authority having jurisdiction (LAJ).
- B. Inlet Threads:
 - 1. Standard National Pipe Threads.
- C. Outlet Threads:
 - 1. Standard National Fire Hose Threads.
- D. Manufacturer:
 - 1. Larsen's Manufacturing Company.
- E. Location and placement of all fire valves to be coordinated with the Construction Manager/General Contractor before installing fire valve/cabinets.

2.9 SPRINKLER HEADS

- A. Type:
 - 1. Recessed pendant sprinkler heads conforming to NFPA 13. Escutcheons to be positive locking. Friction type not acceptable.
 - 2. In sloped ceilings under stairs and ceilings less than 9'-0" are penal / institutional heads.
- B. Upright heads for areas with no ceilings to conform to NFPA 13.
- C. Guards:
 - 1. Chrome metal guards on all heads with exposed pipes. (e.g., gymnasiums, pavilions, mechanical rooms, electrical rooms).
- D. Temperature Ratings:
 - 1. Minimum of 155°F – Ordinary
 - 2. Intermediate – Mechanical, electrical and all similar rooms.
- E. Match existing sprinkler head type in renovation projects.

2.10 FIRE DEPARTMENT CONNECTIONS

- A. Provide Knox Lock caps on all fire department connections.

2.11 EXTRA MATERIALS

- A. Provide Owner with 6 heads and 12 escutcheons in a head box located in sprinkler riser room. Provide one head wrench for each type of head.

PART 3 EXECUTION

3.1 GENERAL

- A. The Sprinkler Systems Contractor shall be responsible for coordinating with all trades. All elevations shown on sprinkler shop drawings are void unless elevations are coordinated with all trades.

3.2 ACCESS DOORS

- A. Provide access doors for concealed valves, controls, and other parts requiring accessibility for operation and maintenance.

3.3 PIPING INSTALLATION

- A. Install piping in a neat and workmanlike manner. All piping routing and elevations to be coordinated with Electrical, Mechanical, and Ceiling Contractors before installation of any piping.
- B. Run the interior fire lines concealed and support from the beams and joists. Exposed piping except in mechanical rooms shall require specific approval of the Architect.
- C. Cut all pipe accurately to measurements established at the building. Install pipe without forcing or springing.
- D. Place all inserts to accommodate the ultimate installation of pipe hangers in the forms before concrete is provided. Set sleeves in place before concrete is poured and masonry walls while they are under construction. Provide sleeves for all pipe passing through foundations, walls, partitions and ceilings.
- E. Caulk pipes through outside walls and floors between pipe and sleeve.
- F. All drains and test connections shall be piped to outside of building.
- G. Paint exposed drain fittings on outside walls to match wall color. Architect to select color.
- H. Provide unions and flanged connections as required.
- I. Space all hangers according to NFPA requirements.
- J. Flexible hose connections shall be one (1) piece from factory. No field modifications.
- K. Install all heads in the center of ceiling tiles.
- L. Coordinate with Electrical and Mechanical Contractor to produce the building sprinkler shop drawings.

3.4 TESTING

- A. Perform such tests as required by the Architect/Engineer, State Fire Marshall's Office, Insurance Services Office, NFPA 13, and local municipal requirements.
- B. Provide all apparatus, temporary pipeline and all other requirements necessary for such tests. Take all due precautions to prevent damage to the building or its contents incurred by such tests. The Contractor will be required to repay and make good any damage so caused at his own expense.
- C. Repair and make good any leaks, defects or deficiencies discovered as a result of the tests. Repeat the tests until all requirements have been fully satisfied.
- D. The following tests will be required by the Engineer, unless otherwise indicated:
 - 1. Subject all water piping to a 2-hour hydrostatic pressure test at 200 psig. Check all horizontal piping to determine if proper drainage is provided. Test piping for tightness before being concealed.
 - 2. Flow tests, water supply capability tests, and any other test required by NFPA 13, Texas State Board of Insurance, or local authorities.

3.5 INSPECTION

- A. The Architect/Engineer shall have the right to inspect the work whenever advisable.
- B. The Contractor shall have a representative present on each inspection and shall give assistance as may be required.
- C. Any piping installed that is in direct conflict with building configuration, design, and intent, and conflicts with installation of mechanical plumbing and electrical components is to be removed and not reinstalled until all parties (sprinkler, mechanical, plumbing, electrical, etc.) are in agreement with utilization of ceiling/attic space. Sprinkler piping to be installed as high as possible and out of the direct path of any HVAC ductwork, plumbing, and electrical pull boxes/j-boxes.

END OF SECTION

SECTION 22 00 10

BASIC PLUMBING REQUIREMENTS

PART 1 GENERAL

1.1 DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Basic plumbing requirements necessary to provide complete installation of all Division 22 work.

1.3 WORK INCLUDED

- A. This section of work comprises furnishing of all materials, equipment, tools, scaffolding, rigging, hoisting, labor and transportation necessary for the complete installation of the plumbing systems as shown on the plans and as specified herein.
- B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Architectural, Structural, Mechanical, Heating, Ventilating, Air Conditioning, Plumbing and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid.
- C. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.
- D. Plumbing Contractor is responsible for all final connections to specified plumbing fixtures and all owner furnished equipment requiring plumbing (drain, water, gas, condensate, air).

1.4 RELATED SECTIONS

- A. The conditions of the Division 01 requirements and the contract requirements which include the General Conditions and the Supplementary Conditions apply to the work of this division.

1.5 CODES & REFERENCE STANDARDS

- A. General
 - 1. Perform all Division 22 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.
 - 2. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes.
 - 3. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.

4. The date of the code or standard that is in effect on the date of issue of the contract documents except when a particular publication date is specified.
5. The Contractor shall be held responsible for verifying all local codes and ordinances that may alter any part of the plans or specifications. The Contractor shall bear all costs for correcting the deficiencies.
6. Where local codes and ordinances are not in writing or on record but a local precedence has been set, the Owner shall pay for any additional cost incurred.

1.6 APPLICABLE CODES AND STANDARDS FOR ALL DIVISIONS 22 WORK

- A. International Building Code
- B. International Gas Code
- C. International Plumbing Code
- D. International Mechanical Code
- E. International Energy Conservation Code
- F. National Electrical Code
- G. American Society of Heating, Refrigerating and Air Conditioning Engineers Standards.
- H. Occupational Safety and Health Administration Standards:
 1. OSHA Standard 2207 - Construction Industry Standards
 2. OSHA 29 CFR Part 1926 – Regulation of Excavation
 3. Texas Underground Facility Damage Prevention Act (H.B. 2295)
 4. All other applicable standards
- I. National Fire Protection Association:
 1. NFPA No. 90A Installation of Air Conditioning and Ventilating Systems
- J. Fire Sprinkler System:
 1. NFPA 13
 2. NFPA 14
 3. NFPA Life Safety Code 101 Section 8-3
 4. All other applicable codes
- K. National Appliance Energy Conservation Act of 1987
- L. Texas State Board of Insurance Standards
- M. Clean Air Act and Clean Air Act Amendments of 1990
- N. State Codes:
 1. Texas Department of Labor Boiler Rules and Regulations
 2. All other applicable codes
- O. Local Municipal Codes and Ordinances
- P. Schedule of Abbreviations:
 1. Reference Standards are listed in Division 22 using abbreviations listed below:

AABC	Associated Air Balance Council
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act

AGA	American Gas Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWE	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CS	Commercial Standard
DIPRA	Ductile Iron Pipe Research Association
DOT	Department of Transportation
DOC	Department of Commerce
FCC	Federal Communications Commission
FM	Factory Mutual
FS	Federal Specification
IBC	International Building Code
ITL	Independent Testing Laboratories
NEC	National Electric Code
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning National Association
TDH	Texas Department of Health
TWC	Texas Water Commission
UL	Underwriters Laboratories

1.7 QUALITY ASSURANCE

- A. Provide complete installations of all systems.
- B. Furnish all items of equipment, material, and labor to complete the Contract even though each and every item necessary is not specifically mentioned or shown.
- C. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern.
- D. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.
- E. All plumbing equipment and fixtures shall be the same brand unless scheduled differently on plans.

1.8 CONTRACTOR'S RESPONSIBILITY

- A. Erect barricades, protective fencing, and signs to prevent injury to personnel on site.
- B. Make permanent connection to utilities or existing lines. Determine depth and location and bid accordingly.
- C. Relocate and repair any existing lines cut by general construction work.
- D. Pay all costs in connection with metering devices.
- E. Plans do not show exact location and elevations of lines, nor do they show all offsets required.

- F. Deviate from plans as required to conform to the general construction and provide proper grading.
- G. Maintain all utility services during construction to existing portions of job that remain.
- H. Procure and pay for all necessary permits or licenses to carry out the work.
- I. Obtain and pay for all the necessary certificates of approval which must be delivered to the Architect before final acceptance of the work.
- J. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.
- K. Protect work from damage by other trades.
- L. Make all tests required by law; pay all costs in connection with the testing.
- M. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.
- N. Provide motor starters, controls, relays, all low-voltage wiring, conduit and wiring related to plumbing and other equipment and devices to form a complete working system. See Division 26 00 00.

1.9 DEFINITIONS

- A. Approval:
 - 1. It is understood that approval must be obtained from the Architect in writing before proceeding with the proposed work.
 - 2. Approval by the Architect of any changes, submitted by the Contractor will be considered as general only to aid the Contractor in expediting his work.
- B. Contractor:
 - 1. The Contractor engaged to execute the work included in a particular section only, even though he may be technically described as a Subcontractor to the General Contractor.
 - 2. If the Contractor engaged to execute said work employs Sub-Contractors to perform various portions of the work included under this Section, he shall be held responsible for the execution of same, in full conformity with Contract Document requirements.
 - 3. The Contractor shall cooperate at all times and shall be responsible for the satisfactory cooperation of his Subcontractors with the other Contractors on the job so that all of the various phases of the work may be properly coordinated without unnecessary delays or damage to any parts of the work of any Contractor.
- C. Provide:
 - 1. Defined as requiring the furnishing and installing of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

1.10 WARRANTY

- A. The Contractor shall warranty his work against defective materials and workmanship for a period of one year from date of acceptance of the job.
- B. Neither the final payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.

- C. He shall remedy any defects due thereto, and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from date of substantial completion.
- D. The Owner shall give notice of observed defects with reasonable promptness.
- E. This Guarantee shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.11 SITE VISIT

- A. Before submitting his proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required.
- B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.12 PROJECT RECORD DOCUMENTS

- A. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building.
- B. Upon submitting his request for final payment, he shall turn over to the Architect/Engineer, for subsequent transmittal to the Owner, a clean, neatly marked set of reproducible plans showing "as installed" work and an electronic file with changes of materials.
- C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication (2 each), prepared in 3 ring binders of sufficient size, black in color, neat in appearance, and turned over to the Architect/Engineer for checking and subsequent delivery to the Owner:
 - 1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
 - 2. Approved fixture brochures.
 - 3. Copies of reviewed shop drawings.
 - 4. Set of operating instructions. Operating instructions shall also include recommended maintenance.
 - 5. Any and all other data and/or plans required during construction.
 - 6. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.
 - 7. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
 - a. General Contractor and all sub-contractors.
 - b. Major Equipment Suppliers.

1.13 TRAINING

- A. Upon completion of the work and at a time designated by the Owner's representative, provide a formal training session for the Owner's operating personnel to include location, operation, and maintenance of all plumbing equipment and systems, some sections have further instructions.

- B. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Owner's representative.
- C. At the conclusion of the instruction, obtain the signatures of the attendees on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Owner's representative and Engineer as a condition of final acceptance.

1.14 PLANS AND SPECIFICATIONS

- A. The plans show diagrammatically the locations of the various lines, ducts, conduits, fixtures, and equipment and the method of connecting and controlling them.
- B. It is not intended to show every connection in detail and all fittings required for a complete system.
- C. The systems shall include but are not limited to the items shown on the plans.
- D. Exact locations of these items shall be determined by reference to the general plans and measurements of the building and in cooperation with other Contractors, and in all cases, shall be subject to the approval of the Architect/Engineer.
- E. The Architect/Engineer reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.
- F. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.15 UTILITIES, LOCATIONS, AND ELEVATIONS

- A. Locations and elevations of the various utilities within the scope of this work have been obtained from the City and/or other substantially reliable sources and are offered separately from the Contract documents, as a general guide only, without guarantees as to accuracy.
- B. The Contractor shall examine the site, shall verify to his own satisfaction the locations, elevations and availability of all utilities and services required, and shall adequately inform himself as to their relation to the work; the submission of bids shall be deemed evidence thereof.
- C. The Contractor shall coordinate all services with the Utility Companies during construction, coordinate changes made by Utility Companies to the design of project, and coordinate with the Owner, Architect/Engineer, and Utility the scheduling of any shutdowns or delays that may occur in providing service.
- D. The Contractor shall verify location, conduct all necessary tests, inspections, coordinate with Owner's representatives and utilities, and check for existing underground utilities and lines before ditching.
- E. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.
- F. Contractor is responsible for coordination of all existing and new utilities at site. Contractor is responsible for protecting and repairing any utilities damaged by installation of pipe. All existing and new landscaping/trees to remain and to be protected unless directed otherwise by Architect/Owner.

1.16 SUBSTITUTION OF PRODUCTS

- A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.
- B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.
- C. The Engineer will consider all such submittals and the Architect will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.
- D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.
- E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.
- F. Requests for substitution are understood to mean that the Contractor:
 - 1. Has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - 2. Will provide the same guarantee for the substitution that he would for that specified.
 - 3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.
- G. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances:
 - 1. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
 - 2. The specified product is unavailable through no fault of the Contractor.
 - 3. The manufacturer refuses to warranty the specified products as required.
 - 4. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
 - 5. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.
- H. Revisions to the plumbing system shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.17 PROTECTION OF EQUIPMENT AND MATERIALS

- A. The Contractor shall take such precautions as may be necessary to properly protect his apparatus from damage.
- B. This shall include the creation of all required temporary shelters to adequately protect any apparatus above the floor of the construction and the covering of apparatus in the completed building with tarpaulins or other protective covering.

- C. Failure to comply with the above to the satisfaction of the Owner's inspector will be sufficient cause for the rejection of the equipment in question and its complete replacement by this Contractor.
- D. All apparatus shall be cribbed up from the floor or ground by the Contractor and covered with tarpaulins or other protective covering where necessary or directed.

1.18 FINAL INSPECTION

- A. It shall be the duty of this Contractor to make a careful inspection trip of the entire project, assuring himself that the work on the project is ready for final acceptance before calling upon the Architect/Engineer to make a final inspection.
- B. To avoid delay of final acceptance of the work, the Contractor shall have all necessary bonds, warranties, receipts, affidavits, etc., called for in the various articles of these specifications, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and shall deliver the same to the Architect/Engineer at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc., before preparing for submission to verify that the terms check with the requirements of the specifications.

1.19 CUTTING AND PATCHING

- A. All Subcontractors shall notify the General Contractor sufficiently ahead of construction of any floors, walls, ceiling, roof, etc., of any openings that will be required for his work.
- B. He shall see that all sleeves required for his work are set at proper times so as to avoid delay of the job.
- C. All necessary cutting of walls, floors, partitions, ceilings, etc., as required for the proper installation of the work under this Contract shall be done at the Subcontractor's expense in a neat and workmanlike manner, and as approved by the Architect/Engineer.
- D. No joists, beams, girders or columns shall be cut by any Contractor without first obtaining written permission of the Architect/Engineer.
- E. Patching of openings and/or alterations shall be provided by the General Contractor.
- F. All openings in firewalls and floors, such as thimbles, shall be completely sealed after installation for a completely airtight and watertight installation. Sealing material shall be non-combustible and UL approved. The installed sealing assembly shall not cause the fire rating of the penetrated structure to be decreased.
- G. All openings in exterior walls shall be sealed watertight.

1.20 IDENTIFICATION

- A. Refer to Section 22 05 54.

1.21 MANUFACTURER'S INSTRUCTIONS

- A. All equipment and devices shall be installed in accordance with these plans and specifications, manufacturer's instructions and applicable codes.

- B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the Contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions.
- C. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.22 RELATED WORK

- A. The various specification sections for this division may or may not include related work listings.
- B. All related work shall be coordinated and provided by the Contractor regardless whether specifically identified or not.

1.23 ELECTRICAL WIRING AND EQUIPMENT FOR PLUMBING SYSTEMS

- A. All wiring, conduit, boxes, equipment (controls, thermostats, relays, contactors, motor starters, heaters, switches) and any other control devices or equipment required to form a complete and properly operating system, shall be the responsibility of this Contractor.
- B. The Electrical Contractor shall only provide line voltage (including hook-up) to all plumbing equipment.
- C. All controls and devices shall be low voltage unless otherwise noted or shown on the plans. Where line voltage controls or devices are noted, the Contractor shall provide complete wiring diagrams (approved by the Engineer) to the Electrical Contractor prior to final hook-up.
- D. The Plumbing and Electrical plans are based on the equipment and devices scheduled as shown on the plans or as called for in the specifications. Should any plumbing equipment or device be changed or approved from those which are shown or noted, all electrical and/or plumbing changes shall be made at the expense of the trade or Contractor initiating the change with no expense to the Owner, Architect, Engineer or their representatives.
- E. All wiring provided by this Contractor shall be installed in a workmanlike manner using tie wraps, labels, anchors and etc. Loose wiring is not acceptable.
- F. All conduit and boxes required in all walls for control purposes (thermostats, switches, etc.) shall be provided by electrical contractor.
- G. All conduit required in attic, clear spaces, or on roof shall be by electrical Contractor.

1.24 OPERATION PRIOR TO COMPLETION

- A. When any piece of plumbing equipment is operable and the Contractor needs to operate the equipment, he may do so providing that he properly supervises the operation.
- B. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner.
- C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all punch list items before final acceptance by the Owner.
- D. The date of acceptance and the start of the warranty may not be the same date.

1.25 SAFETY GUARDS

- A. Contractor shall furnish and install all safety guards required. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

1.26 FLAME SPREAD PROPERTIES OF MATERIALS

- A. All materials and adhesives used for plumbing and insulation shall conform to NFPA and UL life and flame spread properties of materials.
- B. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating as listed for the basic material, the finishes, adhesives, etc., specified for each system and shall be such when completely assembled.

1.27 ASBESTOS

- A. No asbestos or asbestos containing materials shall be permitted in this project.

1.28 LEAD MATERIALS

- A. No lead or lead containing materials shall be allowed in any domestic or potable water supply piping, valves, fixtures, components, equipment or any other item.

1.29 REFRIGERANTS

- A. Chlorofluorocarbons (CFCs) shall not be allowed in any equipment on this project.
- B. Comply with ASHRAE Standards 15 and 34.

1.30 REFRIGERANT RECOVERY AND RECYCLE

- A. Refrigerants shall not be released to the environment.
- B. Contractor shall provide recovery and recycle equipment that has been certified by the Electrical Testing Laboratories or Underwriters Laboratories.
- C. Contractor shall also provide properly trained and certified (in accordance with EPA) personnel for refrigerant work during installation, demolition, start-up, servicing, etc.

1.31 ACCESS CLEARANCE

- A. Proper access to all installed equipment shall be provided. This Contractor shall label all points of access immediately upon installation with a marker pen.
- B. A minimum of 3 feet shall be maintained in front of all access points.
- C. If another trade violates this space, this Contractor shall immediately notify the General Contractor to correct this condition.
- D. When equipment is installed above lay-in ceiling this Contractor shall coordinate with the Ceiling Contractor to provide access without removing part of T-bar ceiling.
- E. No speakers, lights, fire alarm equipment, etc. shall be installed in lay-in ceiling tiles where access is to be gained.

PART 2 PRODUCTS

- A. Not Applicable

PART 3 EXECUTION

3.1 TESTING

- A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation regardless of the season the Contractor shall test all plumbing equipment.
- B. Perform a smoke test on all sanitary sewers and camera all lines and provide owner with a video tape.
- C. Perform gas piping pressure test to comply with HB 1611 and all required City or governing body tests.
- D. Make adjustments as required to ensure proper functioning of all systems.
- E. Special tests on individual systems are specified under individual sections.

3.2 AS BUILT DRAWINGS

- A. Upon substantial completion, Contractor shall submit as built drawings showing all deviations between contract drawings and actual installed conditions.
- B. Show location of all valves in gas and water piping. Submit to Owner.

END OF SECTION

SECTION 22 00 90

PLUMBING SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This section supplements Division 01 Submittal Procedures and contains additional requirements applicable to Division 22 submittals.

1.2 SECTION INCLUDES

- A. This section includes, but is not limited to:
 - 1. Plumbing submittal procedures
 - 2. List of required Division 22 submittals to the engineer
 - 3. This section applies only to the Division 22 specifications. Submittals required by other specification divisions are not included here, even though the same subcontractor may be providing work under other divisions.

1.3 RELATED SECTION

- A. Division 01 – Submittal Procedures

1.4 DEFINITIONS

- A. Product Data: Illustrations, standard schedules, performance charts, instructions, and brochures furnished by the contractor, subcontractor, manufacturer, or supplier to illustrate materials or equipment or to illustrate some portion of the work. Provide a summary of scheduled items with all data in schedules.
- B. Shop Drawings: Drawings, diagrams, schedules and other data specifically prepared for the work by the contractor, subcontractor, manufacturer, or supplier to illustrate some portion of the work.
- C. Equipment/Material Submittal Package: A compilation of the product data, shop drawings, and other items as required by the specifications, submitted near the start of the work. Typically, the specifications require the initial submittal package to be submitted within a certain number of days after the work starts.
- D. Quality Assurance Submittal: Items submitted before and during the execution of a particular portion of the work for the purpose of guarding against defects and deficiencies.
- E. Quality Control Submittal: Items submitted at the completion of a particular portion of the work for the purpose of evaluating completed activities and elements of the work for conformance with contract requirements (e.g. start-up reports).
- F. Closeout Submittals: Items submitted at or near the completion of the contract.

1.5 SUBMITTALS

- A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the architect, engineer and owner.

- B. Manufacturers: Manufacturers submitted shall be as per the acceptable manufacturers listed in each specification section or referenced schedule. For additional manufacturers requiring approval, reference the Substitution of Products article in Section 22 00 10.
- C. Required Submittals: Refer to the Submittals article of each individual Division 22 specification section for the required items to be submitted.
- D. Contractor's Coordination Submittals: The contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the project, but such data shall remain between the contractor and his subcontractors and will not be reviewed by the engineer.
- E. Electronic Submittals: E-mail or other electronic forms of submittals from the contractor are required. The procedures described in this section shall be as follows:
 - 1. The contractor shall supply one electronic copy of the submittal.
 - 2. The electronic files will either be e-mailed to the architect, or posted to a project management and information exchange web site, depending on the architect's requirements. The architect and contractor can distribute copies of the files as desired.
 - 3. The engineer will retain an electronic copy of the submittal and all responses.
- F. Coordination Correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the initial submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the initial submittal package along with a copy of the correspondence.
- G. Unapproved Products: If materials or equipment are installed before being reviewed and approved by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of unapproved materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.
- H. Product Data:
 - 1. Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink or highlighting. Data of a general nature shall not be acceptable.
- I. Shop Drawings:
 - 1. Scale and measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item.
 - 2. Electronic shop drawing submittals are required.

1.6 QUALITY ASSURANCE / CONTROL SUBMITTALS

- A. Quality assurance and quality control submittals may be in the form of documentation or may be in the form of completed physical work that is offered for review by the engineer, architect, or owner.
- B. If documentation is the subject, then submit in a manner similar to the initial submittal package.

- C. If completed physical work is the subject, then the work shall not be concealed, nor shall subsequent work be performed, until the engineer's representative has reviewed the work. If the work is concealed, or if subsequent work is performed, before the engineer's representative has reviewed the work, then the contractor shall be liable for removal and replacement at no additional expense to the owner.
- D. Sequencing:
 - 1. Within 30 calendar days after the contractor has received the owner's notice to proceed, provide the complete submittal package.
 - 2. After the engineer has reviewed the submittal package, make necessary revisions to the submittals as directed by the engineer and resubmit.
 - 3. After the submittal has been reviewed by the engineer, proceed to purchase materials and perform the work.
- E. Scheduling:
 - 1. Failure to submit items that meet the requirements of the contract documents in ample time for review shall not entitle the contractor to an extension of contract time, and no claim for extension by reason of such default shall be allowed. The contractor may be held liable for delays so occasioned.

PART 2 PRODUCTS

- A. Not applicable

PART 3 EXECUTION

3.1 SUBMITTALS

- A. Make submittals of product data, shop drawings, samples, quality assurance submittals, quality control submittals, and other items in accordance with the requirements of this section, applicable sections in Division 22, and additional requirements of each individual Division 22 specification section.
- B. Grouping of Submittals:
 - 1. The submittal package shall be coordinated and included in a single submission. Multiple submissions are not acceptable except where prior written approval has been obtained from the engineer. Partial submittals may be rejected, without being reviewed, as not complying with the provisions of the contract.
 - 2. In the case that multiple submissions are approved, it is the responsibility of the contractor to maintain and update a submittal check list. The contractor shall ensure that all applicable submittal sections are submitted to the Engineer. If a submittal section is not submitted, it will be considered rejected until reviewed by the Engineer.
 - 3. If submittal sections are submitted as individual submittal files, the submittal sections will be grouped and returned as one file with one set of submittal responses.
- C. Electronic Submittal Organization:
 - 1. Electronic submittals are to be submitted as a single PDF file. Within the PDF file, each section shall be bookmarked.
 - 2. Provide an electronic submittal cover sheet that lists at least the following:
 - a. Project name
 - b. Date
 - c. Name and address of architect
 - d. Name and address of engineer

- e. Name, address and telephone number of prime contractor
 - f. Name, address and telephone number of HVAC contractor
 - g. Name, address and telephone number of HVAC supplier
 - 3. Provide an electronic index sheet listing all items submitted.
 - 4. The contractor shall call to the attention of the engineer, clouded in the submittal and noted after the index sheet, any instance in which the submittals are known to differ from the requirements of the contract documents.
 - 5. Organize all required items by specification section. The material for each specification section shall be organized as follows:
 - a. Provide an electronic section cover sheet that lists the same information as the submittal cover sheet, plus the specification number and title and the name, address and telephone number of the vendor or vendor's representative, if applicable.
 - b. Refer to the individual Division 22 specification sections for any required organization of the submittal material within each submittal section.
 - c. Bookmarked sections shall be arranged by specification section number in numerical order.
 - d. Submit in accordance with these procedures and procedures described in Division 01 Submittal Procedures.
 - e. Submittals not organized as described here may be rejected, without being reviewed, as not complying with the provisions of the contract.
- D. Response to engineer's review:
- 1. Review comments:
 - a. Review comments of the engineer will either be shown on the returned sets to the contractor, or shown on a document attached to the sets. If the comments are on an attached document, then the engineer will place a note on the submittal referring to the attached comments. In such cases, the engineer's signature will appear only on the attached document. If the attached, signed document becomes physically separated from the submittal, then the submittal will no longer be considered as being a reviewed submittal.
 - 2. Complete rejection:
 - a. If the submittal is not complete or does not meet the requirements of this specification section, then the engineer may reject the entire submittal and return the submittal without further review or comment. In such cases, the entire submittal shall be completely revised and resubmitted. The resubmittal shall be given a new submittal number and shall be documented and processed as a separate submittal from the original.
 - 3. Held for completion:
 - a. If the submittal is not complete, but is only missing some minor item, the engineer may, at the engineer's sole discretion, hold the submittal rather than rejecting and returning the submittal. In such cases, the engineer will notify the architect and contractor that the submittal is being held for completion. The contractor will be given a predetermined amount of time to provide the missing item. Upon receipt of the missing item, the engineer will insert the missing item into the submittal package and proceed with the review process.
 - 4. Partial rejection:
 - a. The engineer may reject only certain portions of the submittal. In such cases, only those rejected portions or items need to be revised and resubmitted.
 - 5. Provide as corrected:
 - a. The engineer may note a required change to a submitted item, but may not consider the change serious enough to require a resubmittal. In such cases, the engineer will note that the item is to be provided as noted or corrected. In such cases, the contractor may proceed to provide the item. However, if subsequent observations reveal that the noted change was not made, then the contractor shall be liable for removal and replacement of the item at no additional cost to the owner.

6. Reviewed without comment:
a. The contractor may proceed to provide all materials and equipment.

E. Close-out Submittals:

1. Provide close-out submittals in accordance with the requirements of Division 1.

Submittal Checklist – Plumbing			
Listed items shall be organized and bound in a single PDF file in accordance with the specifications. Incomplete or unbound submittals will be rejected unless prior approval is given.			
Required Plumbing submittals in the initial submittal package include but are not limited to the following. Always refer to the individual specification sections.			
Specification Reference			Description
☐	22 00 10	☐ Basic Plumbing Requirements	
☐	22 05 24	☐ Valves - General	☐ Valves
☐	22 05 54	☐ Plumbing Identification	☐ Equipment labels ☐ Piping and control diagram signs ☐ Pipe markers ☐ Valve tags ☐ Underground warning tape
☐	22 07 20	☐ Piping Insulation	☐ Pipe insulation
☐	22 11 17	☐ Domestic Water Piping & Appurtenances	☐ Domestic water piping ☐ Valves ☐ Water hammer arrestors
☐	22 13 17	☐ Soil, Waste & Sanitary Drain Piping & Appurtenances	☐ Drain pipe & fittings ☐ Clean outs ☐ Trap primers
☐	22 13 18	☐ Condensate Piping	☐ Condensate piping
☐	22 33 34	☐ Access Doors	☐ Access doors
☐	22 40 01	☐ Plumbing Fixtures & Fixture Carriers	☐ Water heaters ☐ Expansion tanks ☐ Circulating pumps ☐ Water hammer arrestors ☐ ADA Accessories ☐ Science Room Solenoid valves ☐ Water closet ☐ Urinals ☐ Lavatories ☐ Carriers ☐ Faucets ☐ Sinks ☐ Electric water coolers ☐ Mop sinks ☐ Showers ☐ Wash fountains ☐ Floor drains ☐ Flush valves ☐ Thermostatic mixing valves
☐	22 66 54	☐ Acid/Chemical Waste & Vent Piping	☐ CPVC acid waste piping and fittings

END OF SECTION

SECTION 22 05 24

VALVES - GENERAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. General requirements for valves

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 05 30 - Pipe and Pipe Fittings - General
- C. Section 22 11 17 - Domestic Water Piping and Appurtenances

1.4 REFERENCES

- A. ASTM 763 - Standard Specification for Copper Alloy Sand Castings for Valve Applications
- B. ASTM 61 - Standard Specification For Steam or Valve Bronze Castings
- C. ASTM C27450 - Standard Specification for Brass Rod, Bar & Shapes
- D. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges & Pipe Fittings
- E. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications
- F. ASTM - American Society of Testing Materials
- G. ASTM A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
- H. ASTM B813-00e1 - Standard Specification for Liquid & Paste Fluxes for Soldering of Copper & Copper Alloy Tube
- I. ASTM B828-02 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- J. ASTM B88-02 - Standard Specification for Seamless Copper Water Tube
- K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings
- L. PDI - Plumbing & Drainage Institute

1.5 QUALITY ASSURANCE

- A. Manufacturer to stamp valve to show that shell and seat tests have been successfully completed.

1.6 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.

PART 2 PRODUCTS

2.1 MATERIAL SPECIFICATIONS

- A. Bronze - 150 psi maximum: ASTM B62
- B. Bronze - 300 psi maximum: ASTM B61
- C. Cast Iron: ASTM A126, Class B
- D. Cast Carbon Steel: ASTM A216, Grade WCB
- E. Forged Carbon Steel: ASTM A105, Grade II
- F. Brass - Lead free, dezincification resistant arsenical brass, 125 psi maximum, ASTM 763

2.2 CONSTRUCTION

- A. Provide valves designed for repacking under pressure when fully opened.
- B. Equip with packing suitable for intended service.
- C. Furnish with gland followers.
- D. Provide valves rated greater than the design temperature and pressure for the intended system.
- E. All domestic cold water and hot water valves 2" and less shall be full port ball valves.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install valves and stops in accessible locations.
- B. Provide where shown or as required to make system complete and readily maintained.
- C. Provide access doors for all inaccessible valves.
- D. Provide as built drawings locating all valves in gas and water lines.

END OF SECTION

SECTION 22 05 30

PIPE AND PIPE FITTINGS - GENERAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Pipe
- B. Pipe fittings

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 05 24 - Valves - General
- C. Section 22 07 20 - Piping Insulation
- D. Section 22 11 17 - Domestic Water Piping and Appurtenances
- E. Section 22 13 17 - Soil, Waste, and Sanitary Drain Piping, Vent Piping, and Appurtenances
- F. Section 22 13 18 - Condensate Piping
- G. Section 22 40 01 - Plumbing Fixtures and Fixture Carriers
- H. Section 22 66 54 - Chemical Waste and Vent Piping

1.4 REFERENCES

ASME	American Society of Mechanical Engineers
ASTM C564-97	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D2665-02a	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E84-01	Standard Test Method for Surface Burning Characteristics of Building Materials
UL	Underwriters Laboratory
NFPA 90 A & B	Installation of Air Conditioning & Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems
CISPI-310	Cast Iron Soil Pipe Institute

1.5 QUALITY ASSURANCE

- A. Valves:
 - 1. All valves to be from a single manufacturer.

- B. The welder, employed on this project, shall have passed qualification tests as prescribed by the National Pipe Welding Bureau, or other reputable testing laboratory using qualification procedures as recommended by the ASME Boiler Construction Code or the American Welding Society Standards.

1.6 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.
- B. Submit product data indicating dimensions, general assembly and use.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

- A. The type of pipe and fittings necessary for each system is specified in the section on that system.

2.2 DISSIMILAR MATERIALS

- A. Use approved adapters such as Di-Electric Unions manufactured for making piping connections between dissimilar materials such as copper and brass or copper and steel.

2.3 ESCUTCHEONS

- A. Usage:
 - 1. All exposed lines passing through floors, walls and ceilings.
- B. Material:
 - 1. Chrome plated steel
- C. Flange size:
 - 1. As necessary to cover penetrated openings.
- D. Plate size:
 - 1. As necessary to fit pipe or insulation and securely lock in place.
- E. Manufacturer/Model:
 - 1. Engineered Brass Company, Type CF

2.4 SLEEVES

- A. Application:
 - 1. Provide sleeves for all pipes and conduits which pass through a concrete slab, masonry wall/concrete wall, roof or other portion of the building structure.
- B. Above Grade and/or dry locations:
 - 1. Material:
 - a. 20 or 22 gauge galvanized steel.
 - 2. Size:
 - a. As necessary to allow free passage of the insulated pipe.

- C. Below Grade and/or moist locations:
 - 1. Material:
 - a. ASTM D-2665 Schedule 40 PVC. When PVC not allowed by code, use schedule 40 galvanized steel.
 - b. Return Air Plenum:
 - (1) Schedule 40 galvanized steel.
- D. Passing through fire-rated enclosures:
 - 1. Material:
 - a. Galvanized or black steel pipe.
 - b. Non-combustible.
 - c. PVC will not be allowed.
- E. Penetration Seal:
 - 1. Seal penetration with Fiberfrax Fyre putty or one-component ceramic fiber-based putty fill, void or cavity material, UL rated material classified for use in through-penetration firestop systems nos. 124, 125, 150 and 151.
 - 2. Flame Spread/Smoke Contribution:
 - a. 0/0 in accordance with ASTM E-84.

2.5 VALVES, UNIONS, STOP COCKS, ETC.

- A. Applications:
 - 1. Ball Valves:
 - a. Provide accessible valves at each group of plumbing fixtures and at each piece of equipment on all piping systems for isolation of fixtures and equipment. All valves shall be full port valves.
- B. All Other Valves, Unions, Stop Cocks, Etc.:
 - 1. Provide at each group of plumbing fixtures and at each individual fixture, at each piece of equipment, at all inlet and outlet connections for hot and cold water and gas.
 - 2. Provide Di-Electric Unions at connection of dissimilar pipe materials to prevent electrolysis.
- C. Type:
 - 1. Suitable for 125 lbs. working pressure.

2.6 PIPE SUPPORTS

- A. Hangers:
 - 1. 2" and Smaller Piping:
 - a. May be split cast ring type with fastening device in walls and chases.
 - 2. Copper Piping:
 - a. Copper plated ferrous hangers.
 - 3. All Other Above Ceiling Locations:
 - a. Adjustable clevis type. Hangers to accommodate circumference of pipe and saddles.
- B. Hanger Rods:
 - 1. Type:
 - a. Minimum 3/8 inch diameter with machine threads.
- C. Minimum Steel Hanger Rod Diameter for Individually Suspended Horizontal Pipes:
 - 1. 2" and smaller diameter pipe:
 - a. 3/8"
 - 2. 2-1/2" to 3 - 1/2" diameter pipe:
 - a. 1/2"

- 3. 4" to 5" diameter pipe:
 - a. 5/8"
- 4. 6" diameter pipe or larger:
 - a. 3/4"
- D. Hanger Manufacturers:
 - 1. Anvil
 - 2. Elcen
 - 3. ERICO
 - 4. F&S Manufacturing
 - 5. Fee & Mason
 - 6. PHD
- E. In wall pipe supports:
 - 1. Metal strut, manufactured pipe clamps
- F. In wall pipe support manufacturers:
 - 1. Holdrite or Equivalent

PART 3 EXECUTION

3.1 PIPE INSTALLATION

- A. Install piping in a neat and workmanlike manner.
- B. Install each of the piping systems to provide for expansion and contraction.
- C. Solder all joints when the system is not under strain.
- D. Expansion Offsets:
 - 1. Copper Piping:
 - a. Use developed length Copper Tube Handbook 411-R as published by Copper Development Association, Inc.
 - 2. Steel Piping:
 - a. Use developed per Carrier System Design Manual, Part 3 Piping Design.
- E. Furnish necessary spring pieces and offsets as required.
- F. Conceal all of the piping systems in chases, above ceilings, in walls and in finished areas.
- G. Run Exposed piping only in machinery spaces and unfinished areas as specified or as shown on the plans.
- H. Install all necessary fittings and offsets to hold the piping close to walls and ceilings.
- I. Where these lines run exposed, obtain a clearance from the Engineer in writing before making the installation.
- J. Install piping in the most advantageous manner possible with respect to headroom, valve access, openings, equipment clearances, and clearances for other work.
- K. Give particular attention to piping in the vicinity of equipment.
- L. Preserve the maximum access to various equipment parts for maintenance.

- M. Do not cut or weaken any structural member.
- N. Cut all pipes accurately to measurement determined at the site.
- O. After cutting pipe, ream it to remove burrs.
- P. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing.
- Q. Use fittings to make all changes in direction.
- R. Field bending and mitering are prohibited.
- S. Make all connections to equipment using flanged joints or unions.
- T. Make reducing connections with reducing fittings only.
- U. Do not allow piping to pass through or over designated electrical rooms.
- V. Compression fittings are not allowed.

3.2 VALVES, UNIONS, STOP COCKS, ETC.

- A. Locate all valves so that their bonnets may be easily removed.
- B. Move all flange valves shown in horizontal positions so that valve stem is inclined one bolt hole above the horizontal position.
- C. Make-up all screwed pattern valves placed in horizontal lines so that their valve stem is inclined at an angle of 30 degrees above the horizontal position.
- D. All valve stems must be true and straight at the time the system is tested for final acceptance.
- E. Pack all valves and leave perfectly tight at the completion of the work.
- F. Provide access doors as required for these valves.
- G. Furnish locations of all access doors to the Architect/Engineer.

3.3 PIPING JOINTS

- A. Screwed Pipe Joints:
 - 1. Provide full cut pipe threads.
 - 2. Assemble joints with an approved compound applied to only the male threads.
 - 3. Leave a maximum of three pipe threads exposed where the joint is assembled.
- B. Welded Pipe Joints:
 - 1. Fuse weld by using a metallic arc welding process.
 - 2. Conform to the current recommendations of the American Welding Society for all welding operations.
- C. Mechanical Coupling Joints:
 - 1. Assemble in strict accordance with the recommendations of the coupling joint manufacturer.
 - 2. Use bolts, fasteners, gaskets and lubricants that are a product of or adhere rigidly to the specification requirements of the joint manufacturer.

- D. Solder Joints:
 - 1. Assemble with square cut pipe using a pipe cutter.
 - 2. Hacksaw-cut pipe ends will not be acceptable.
 - 3. Ream open pipe end to full size.
 - 4. Burnish both the pipe and fitting absolutely clean.
 - 5. Apply brazing flux to both the pipe and the fittings.
 - 6. The use of corrosive acid flux will not be permitted.
 - 7. Charge the pipe and fittings with nitrogen gas during the brazing.
- E. PVC Pipe Joints:
 - 1. May be solvent cemented using the proper cement recommended for the particular materials.
 - 2. Cut all pipe square and clean both pipe and fittings of all soil, dirt, oil and grease.
 - 3. Make solvent joints in accordance with the applicable ASTM Standards.
 - 4. Allow joints to dry before testing.
 - 5. If any leak occurs during the water test, then replace the defective joint.
 - 6. Comply with requirements of the NSF Standard 14 for all solvent cements and primers and label to identify the laboratory certifying compliance for the particular cement and primer being used.
 - 7. Plastic pipe and fittings for sewer and water pressure lines may also be joined by use of elastomeric (O-ring gasket) joints when the respective standards for the materials so specify. No-Hub fittings are not allowed on PVC sanitary sewer and storm drain piping under slab or underground.
 - 8. Do not use pipes with cracked bells.

3.4 SLEEVES

- A. Above Grade and/or Dry Locations:
 - 1. Walls:
 - a. Mount flush on both sides.
 - 2. Floors:
 - a. Mount 2 inches above finished floor in pipe chases.
- B. Below Grade and/or Moist Locations:
 - 1. Install suitable flange in the center of wall or floor to form a waterproof passage.
 - 2. Fill the void space around the pipe with jute twine or Oakum caulk or an asphalt based compound to insure a waterproof penetration.
- C. Passing Through Fire-Rated Enclosure:
 - 1. Fill the void space around the pipe in accordance with NFPA requirements.
 - 2. Do not allow the sleeve installation to lower the fire rating of the assembly.

3.5 SECURING AND SUPPORTING OF PIPE

- A. Support all pipe from the building structure by means of approved hangers and supports while maintaining required grade and pitch, preventing vibration and providing for expansion and contraction.
- B. Secure all hangers to approved inserts wherever possible.
- C. Set hanger inserts in place when the concrete is poured.
- D. If Joists Are Used for Attachment:
 - 1. 2" diameter or smaller:
 - a. May be attached to the bottom of joists.

2. Greater than 2" diameter:
 - a. Must be attached to the top cord of the joists.
 3. Do not support any piping and trapeze hangers from joist bridging on roof and floor deck.
- E. If Structural Steel Framing Is Used for Attachment:
1. Use approved beam clamps.
 2. Where required, install channels to span between framing members.
 3. Do not attach hangers to the roof deck or cross bracing.
- F. Hanger Spacing:
1. Schedule 40 PVC Piping:
 - a. All Sizes:
(1) 4'-0"
- G. Ferrous (Schedule 40) Piping:
1. 1/2" diameter pipe:
 - a. 6'-0" or less
 2. 3/4" diameter pipe:
 - a. 8'-0" or less
 3. 1-1/4" diameter pipe:
 - a. 10'-0" or less
 4. Vertical:
 - a. Every Floor Level Minimum
- H. Copper (Water Tube) Piping:
1. Smaller Than 1 1/4":
 - a. 6'-0"
 2. 1 1/2" and Larger:
 - a. 10'-0"
 3. Vertical:
 - a. 10'-0"
- I. Cast Iron Piping:
1. All pipe sizes:
 - a. One hanger per length of pipe and not exceeding 5'-0" O.C.
 2. Vertical:
 - a. Every Floor Level Minimum
- J. Vertical Lines:
1. Adequately support at their bases, either by a suitable hanger placed in the horizontal line near the riser, or by a base fitting set on a pedestal or foundation.
 2. Support from each floor slab by means of an approved clamp-type support which bears on the slab or beam.
- K. Change of Direction:
1. Install supports within two feet of change of direction.
 2. Brackets of approved type may be used along the walls.
 3. Install hangers within 2 feet of each change in vertical or horizontal direction, pipe tees and on each side of valves, strainers, etc.
 4. Multiple horizontal pipes, smaller than 12" diameter pipe, may be supported on trapeze hangers. Space trapeze hangers in accordance with the schedule for pipe spacing based upon the smallest size pipe.
 5. Properly size the trapeze members for the piping load they are to support. The number of pipes on the trapeze must be approved by the Engineer to prevent overloading of the building structure.

6. Where pipes are insulated, oversize the hanger accordingly to accommodate the outside diameter of the insulation. Provide half-round 16 gauge galvanized steel shields, not less than 12" long and rolled to fit the insulation diameter, between the insulation and the hanger.
7. When pipe is guided at top and bottom, cover the entire pipe circumference with metal shields.
8. Adhere metal shield to the insulation so that the metal will not slide with respect to the insulation.
9. Wood struts shall not be used to support piping in walls.

3.6 EXCAVATION AND BACKFILLING

- A. Excavation:
 1. Call utility companies before digging.
 2. Call Notifications Center before digging.
 3. Excavate trenches for underground piping to the required depths with bell holes being provided as necessary to insure uniform bearing. Dig all bell holes after the trench has been graded.
 4. Refill excavation below the required grade of piping with fine granular material to the pipe grade.
 5. Where rock is encountered, excavate to a grade 3 inches below the lowermost part of the pipe and refill with fine granular materials to the pipe grade.
 6. Sheath, brace, pump or bail the trenches as required to protect workmen and structures and to permit execution of the work. A trench greater than 5 feet deep will not be permitted unless the sides are cutback at 45 degrees to 5 feet or less. If this cannot be accomplished, hire a Registered Engineer to design shoring.
 7. Install all underground piping below the frost line and in no case less than 18 inches below the surface.
- B. Sand Embedment Backfill:
 1. Sand for embedment shall be a free flowing material which contains no clay, is reasonably free from organic material and does not form a muck or mud when wet. The gradation shall be such that a minimum of 95% is retained on a #100 sieve. The P.I. of the soil fraction passing the No. 40 sieve shall not be greater than 5.
- C. Backfilling:
 1. Do not backfill until after all required tests have been performed and approved.
 2. Perform all backfilling with approved materials well compacted in place in accordance with the General Specifications including Division 02.
- D. Rigid Pipe (Ductile Iron):
 1. Backfill with select materials of the proper moisture content to obtain a support under the lower half of the pipe.
 2. Compact to a density of 90% AASHTO T-180 modified or better.
- E. Non-Rigid Pipe (PVC):
 1. Backfill as specified for rigid pipe except backfill the entire trench surrounding the pipe barrel to a point 12 inches above the top of the pipe with select material compacted to a density of 90% AASHTO T-180 modified or better.
 2. Lay backfill according to manufacturer's recommendations.
- F. Job Photographs:
 1. Contractor is to provide digital photographs of all pipe showing sand embedment prior to covering trenches.

3.7 EQUIPMENT PLUMBING CONNECTIONS

- A. Make all final connections to all pieces of equipment which require natural gas, water, drain, waste or vent connections.
- B. Provide all required shut-off cocks, valves, drain valves and traps.

3.8 TESTING AND INSPECTION

- A. Perform all tests as specified in Division 22 or as required by the Engineer or by the Local, Federal, and State Bureaus having jurisdiction and under their supervision during the progress and upon completion of work.
- B. Include costs of all required tests in your bid.
- C. Provide all apparatus, temporary pipeline and all other requirements necessary for such tests.
- D. Take all due precautions to prevent damage to the building or its contents incurred by such tests as the Contractor will be required to repay and make good any damage so caused at his own expense.
- E. Immediately repair any leaks, defects or deficiencies discovered as a result of the tests. Repeat until test requirements are in full compliance.

3.9 IDENTIFICATION OF PIPING AND EQUIPMENT

- A. Mark all piping to show the service and direction of flow.
- B. Place markers at each branch of tees, at equipment connections, and change of direction and at 20 foot intervals. Minimum of one (1) marker in each room.
- C. Install valve tags on all valves.
- D. Frame under glass cover and hang a type written list including the valve number, type of service, and location of each valve in the boiler mechanical room.
- E. Mark all valve numbers corresponding to this system of identification on the as-built drawings which will be delivered to the Owner upon completion of the work.

END OF SECTION

SECTION 22 05 33

HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes a UL Listed, CSA Certified, or FM Approved temperature maintenance heat tracing system of domestic hot water supply consisting of self-regulating heating cable, connection kits, and energy efficient time based control.
- B. The system complies with California Title 24 energy requirements
- C. Related Requirements
 - 1. Section 22 05 33 - Heat Tracing for Plumbing Piping
 - 2. Section 22 07 19 - Plumbing Piping Insulation
 - 3. Section 25 34 00 - Integrated Automation Instrumentation and Terminal Devices for Plumbing
 - 4. Section 25 54 00 – Integrated Automation Control of Plumbing

1.2 REFERENCES

- A. Reference Standards
 - 1. UL515 – Electrical Resistance Heat Tracing for Commercial Applications
 - 2. IEEE 515.1-2012 Standard for the Testing, Design, Installation & Maintenance of Electric Resistance Trace Heating for Commercial Applications.
 - 3. CSA Standard C22.2 No. 130-03 Requirements for Electrical Resistance Heating Cables & Heating Device Sets
 - 4. NFPA 70 - National Electrical Code
 - 5. CSA Standard C22.1 – Canadian Electrical Code

1.3 SYSTEM DESCRIPTION

- A. System for temperature maintenance of domestic hot water supply systems with energy efficient time based control, multi-point monitoring, integrated ground-fault circuit protection and Building Management System (BMS) communication capabilities.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- A. Product Data
 - 1. Heating cable data sheet
 - 2. UL, CSA, FM approval certificates for hot water temperature maintenance systems
 - 3. Hot water temperature maintenance design guide
 - 4. System installation and operation manual
 - 5. System installation details
 - 6. Connection kits and accessories data sheet
 - 7. Controller data sheet
 - 8. Controller wiring diagram
- B. Shop Drawings
 - 1. Provide heat tracing circuit layout drawings indicating power connections, tees, end seal, cable length and circuit cable length.

1.5 QUALITY ASSURANCE

- A. Source Limitations: All system components shall be sourced from a single manufacturer, under no circumstances shall any components be installed other than those supplied by the cable manufacturer, to ensure system integrity and meet warranty requirements.
- B. Qualifications
 - 1. Manufacturers
 - a. Manufacturer to show minimum of thirty (30) year experience in manufacturing electric self-regulating heating cables.
 - b. Manufacturer will be ISO-9001 registered.
 - c. Manufacturer to provide products consistent with IEEE 515.1 and CSA 22.2 No 130-03 requirements.
 - d. The self-regulating temperature maintenance cable shall be qualified and tested to demonstrate a useful lifetime in excess of 40 years.
 - e. The manufacturer shall provide an extensive global reference list for this application, including installations that have been in operation for over 15 years.
 - 2. Installers
 - a. System installer shall have complete understanding of product and product literature from manufacturer or authorized representative prior to installation. Electrical connections shall be performed by a licensed electrician.
 - 3. Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.
- C. Certifications
 - 1. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified, or FM Approved for hot water temperature maintenance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery And Acceptance Requirements
 - 1. Deliver, store and handle products to prevent their deterioration or damage due to moisture, temperature changes, contaminates or other causes.
 - 2. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
 - a. Product and Manufacturer
 - b. Length/Quantity
 - c. Lot Number
 - d. Installation and Operation Manual
 - e. MSDS (if applicable)
- B. Storage And Handling Requirements
 - 1. Store the heating cable in a clean, dry location with a temperature range 0°F (-18°C) to 140°F (60°C).
 - 2. Protect the heating cable from mechanical damage.

1.7 WARRANTY

- A. Manufacturer Warranty
 - 1. Pentair Thermal Building Solution warrants all goods listed below for two (2) years from date of purchase against faulty workmanship and use of defective materials when such goods are properly installed, operated, and maintained according to product documentation. See Limited Product Warranty (H57396) at www.pentairthermal.com.
 - a. Heating cables, connection kits & accessories
 - b. Thermostats, controllers, panels contactors, sensors and accessories

B. Special Warranty

1. Contractor shall provide the owner an extended product warranty for the heat tracing products listed below. The contractor must complete and forward to owner the Installation, Inspection or Commissioning Record(s) located in the back of installation manual for the heat trace system being installed, and complete the online warranty registration form at www.pentairthermal.com within thirty (30) days from the date of installation, otherwise only standard limited warranty applies. See Limited Product Warranty Extension details (H57397) at www.pentairthermal.com
 - a. Heating Cable & Components = Ten (10) Years from Date of Purchase
2. Products not automatically offered with a 10 year manufacturer's warranty, as a standard matter of course, will not be allowed. Warranty information must be published on the manufacturer's website

PART 2 PRODUCTS

2.1 HEAT TRACING SYSTEM

A. Manufacturers

1. Basis of Design Manufacturer: Subject to the compliance with requirements, provide Raychem heat tracing products of **Pentair Thermal Building Solutions, Redwood City 94063, 800-545-6258**; Email: thermal.info@pentair.com Website: www.pentairthermal.com
2. Submit comparable products of one of the following for approval by Plumbing Engineer:
 - a. Submit request for substitutions in accordance with Instructions to Bidders and Division 01 General Requirements.

B. Materials

1. Heating cables shall be Raychem HWAT-R2, self-regulating temperature maintenance heating cables specifically designed for this application, tested and approved to IEEE 515.1 and CSA 22.2 No 130-03.
 - a. The construction of the self-regulating temperature maintenance heating cable shall consist of a continuous core of conductive polymer that is radiation crosslinked, extruded between two (2) 16 AWG nickel-plated copper bus wires that varies its power output in response to pipe temperature changes.
 - b. The heating cable shall have a modified polyolefin inner jacket for dielectric integrity long life expectancy.
 - c. The heating cable shall have a laminated aluminum foil layer (Mylar wrap) for additional mechanical protection and shall act as a plasticizer diffusion shield.
 - d. The heating cable shall have a thicker gauge (5/24) tinned copper braid with minimum 70% coverage for ground path and mechanical ruggedness.
 - e. The heating cable shall have a **POLYOLEFIN** outer jacket printed with cable model #, agency listings, batch number and meter marks (for ease of installation within maximum circuit length).
 - f. The heating cable shall have a self-regulating factor of at least 70 percent for HWAT-R2. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 40°F pipe temperature to 150°F pipe temperature
 - g. The heating cable shall operate on line voltage of 208 volts without the use of transformers.
 - h. The heating cable shall be included in a UL Listed, CSA Certified, or FM Approved system.
 - i. Constant wattage cables are not acceptable.
2. Heating Cable Connection Kits
 - a. Heating cable connection kits shall be Raychem RayClic.

- b. Contractor shall provide power connections, splices/tees, and end seal kits to properly connect & terminate the heating cable.
- c. All splices, tees and crosses shall be installed underneath the pipe insulation with service loops installed to allow for future service of the piping.
- d. Connection kits shall be rated Type 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require the installing contractor to cut into the heating-cable core to expose the bus wires.
- e. Connection kits shall be UL Listed, CSA Certified, and FM approved.
- 3. Attachment of Heating Cable
 - a. Attachment method of heating cable to the piping shall be Raychem model
 - (1) GT-66 – general purpose, high temperature, glass filament tape for installation @ 40°F and above. Contractor to fix the heating cable to the pipe every 12" by wrapping the GT-66 tape around the pipe & over the heating cable.
 - (2) AT-180 – aluminum tape, high temperature for all plastic piping for installations @ 32°F and above. Tape is installed lengthwise over the heating cable.
 - b. Metal cable ties are not permitted
- 4. Identification of Heating Cable System
 - a. Contractor shall provide & install Raychem model **ETL "Electric Heat Traced" labels** on exterior of pipe insulation every ten (10) feet on opposite sides of the pipe for the entire length of heat traced piping.
 - b. In addition, all splices, tees, crosses and power connections shall be labeled on the exterior of the pipe insulation indicating that presence of a connection kit.
- 5. Energy Efficient Control System
 - a. Single Circuit Local Digital Controller
 - (1) All self-regulating heating cable shall be controlled via an energy saving, programmable single circuit controller to provide adjustable maintained temperatures in the range of –40°F to 140°F (–40°C to 60°C), known as Raychem C910-485, manufactured by Pentair.
 - (2) Contractor shall provide ONE (1) Raychem model C910-485 controller for each heat tracing circuit as indicated on heat tracing schedule.
 - (3) Controller shall include a self-test function to verify heat tracing integrity at least once every 24 hrs.
 - (4) See table below for complete list of required controller capabilities:

Supply Voltage	100 VAC to 277 VAC		
Enclosure	NEMA4X FRP		
Operating Temp Range	–40°F - 140°F		
Display	6 character alphanumeric LED		
Control	Relay Type: DP, mechanical	Voltage: 277 VAC max	Current: 30 A @ 104°F
Control Algorithms	On/Off		
	Proportional Ambient Sensing Control for energy saving		
Monitoring			
	Temperature	Low Alarm: 0°F to 180°F	High Alarm: 0°F to 200°F
	Ground Fault	Alarm Range: 20 mA -100 mA	Trip Range: 20 mA -100 mA
	Current	Low alarm range: .3 A to 30 A or off	
	Autocycle Test	Interval: 1-240 minutes or 1-240 hours	
Temp Sensor Inputs	Quantity: Two (2)	Type: 100 Ω, platinum 3 wire	
Alarm Outputs			
	AC Relay: Isolated solid state triac, SPST, 0.75A max, 100 VAC to 277 VAC nominal		
	Dry Contact Relay: Pilot duty, 48 VAC/DC, 500 mA maximum, 10 VA max. resistive switching		
	Outputs: Normally Opened or Normally Closed		

Stored Parameters			
	Minimum Temperature	Maximum Temperature	Max. ground fault current
	Maximum Heater current	Contactor cycle count	Time in Use
Alarm Conditions			
	Low & high temperature	Low current	Ground fault alarm & trip
	RTD failure	Loss of programmed values	EMR failure
Communications			
	Protocol: Modbus RTU	Topology: daisy chain	26 AWG shielded twisted pair

6. Temperature Sensors
 - a. Ambient control - Contractor shall provide ONE (1) Raychem model RTD-200, 100 Ω , platinum 3-wire RTD for ambient temperature sensing for each C910-485 heat tracing controller. Control shall use proportional ambient sensing for enhanced energy saving
 - b. Line sensing control - Contractor shall provide ONE (1) Raychem model RTD-50CS, 100 Ω , platinum 3-wire RTD for pipe temperature sensing for each C910-485 heat tracing controller.
 - c. Fire sprinkler control – Per IEEE 515.1, Contractor shall provide ONE (1) Raychem model RTD-200, 100 Ω , platinum 3-wire RTD for ambient temperature sensing and ONE (1) Raychem model RTD-50CS, 100 Ω , platinum 3-wire RTD for pipe temperature sensing for each C910-485 heat tracing controller.
7. Approval
 - a. The complete heat trace system (heating cable, connection kits, and controller) shall be listed by a Nationally Recognized Testing (NRTL), and marked for intended use of:
 - (1) Freeze protection of above ground water piping
 - (2) Freeze protection of below ground water piping
 - (3) Freeze protection of standpipes, mains and branch fire sprinkler piping
 - (4) Grease flow maintenance of above ground, sanitary grease waste piping
 - (5) Grease flow maintenance of below ground, sanitary grease waste piping
 - (6) Fuel flow maintenance of above ground fuel piping
6. Thermal Pipe Insulation
 - a. Pipes must be thermally insulated in accordance with the HWAT Design Guide requirements. No deviation from the insulation schedule will be allowed.
 - b. Thermal insulation must be a type that is flame retardant (closed-cell or fiberglass) with waterproof covering.
7. Approval
 - a. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified, or FM Approved for hot water temperature maintenance.
 - b. The temperature maintenance system shall have a design, installation and operating manual specific to domestic hot water piping.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verification Of Conditions
 1. Prior to installation of heating cable system, verify that all piping which will be heat trace has passed all hydrostatic/pressure test and is signed off by plumbing inspector.
- B. Preinstalling Testing
 1. Prior to installing heating cable on the piping an insulation resistance test shall be performed by the installing contractor to ensure integrity of heating cable as describe in the installation & maintenance manual.

3.2 PREPARATION

- A. Protection Of In-Place Conditions
 - 1. All heating cable ends shall be protected from moisture ingress until cable is terminated.
 - 2. Acceptable methods are installing RayClic-E end seals.

3.3 INSTALLATION

- A. Comply with manufacturer's recommendations in the HWAT System Installation and Operation Manual – H57548.
- B. Apply the heating cable linearly on the pipe after piping has successfully completed any pressure tests. Secure the heating cable to piping with fiberglass tape.
- C. Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.
- D. Any deviation in circuitry, insulation, or piping material must be approved by engineer prior to execution.
- E. Distribution pipes & express risers must be isolated electrically. Each shall have their own circuit(s).
- F. Branch lines shall be grouped electrically based on location.
- G. All power connections must be located in accessible areas. Access panels for power connection shall be a minimum of 12" x 12" and within reach of power connection kit.
- H. Refer to Electrical Specification for power connection locations.
- I. All power, tee, and splice connection points shall be shown on the plumbing as-built.
- J. Installation training, provided by an authorized manufacturer's representative must be completed prior to work mobilization.
- K. Interface With Other Work
 - 1. Grounding of controller shall be equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 2. Connection of all electrical wiring shall be according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 3. Pipe Insulation shall be thermally insulated in accordance with the HWAT design guide requirements.

3.4 FIELD QUALITY CONTROL

- A. Initial start-up and field testing (commissioning) of the system shall be performed by factory technician or factory representative per the owner's requirements.
- B. Field Tests And Inspections
 - 1. The system shall be commissioned in accordance to the HWAT Installation and Operation manual.

2. The heating cable circuit integrity shall be tested using a 2500 Vdc megohmmeter at the following intervals:
 - a. Before installing the heating cable
 - b. After heating cable has been installed onto the pipe
 - c. After installing connection kits
 - d. After the thermal insulation is installed onto the pipe
 - e. Prior to initial start-up (commissioning)
 - f. As part of the regular system maintenance
 - g. Minimum acceptable insulation resistance shall be 1000 megohms or greater
 3. The technician shall verify the insulation schedule is in compliance with the HWAT Installation and Operation manual.
 4. The technician shall verify that the ACS-30 control parameters are set to the application requirements.
 5. The technician shall verify that the ACS-30 alarm contacts are corrected connected to the BMS.
 6. The technician shall verify that the ACS-30 and ProtoNode-RER are configured correctly with the BMS.
- C. Non-Conforming Work
1. Any heat tracing circuit which fails the any of the above test must be corrected prior to commissioning or startup of the system.
- D. Manufacturer Services

3.5 SYSTEM STARTUP

- A. Provide a factory-certified technician or manufacturer's representative for start-up & commissioning of the heat tracing system and controller.
- B. Coordinate all controller settings with plumbing engineer prior to programming the controller.
- C. Provide commissioning report in submittals package to owner.

END OF SECTION

SECTION 22 05 54

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Identification required for plumbing systems.
- B. Code required identification not shown on plans nor specified herein shall be provided.

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 05 30 - Pipe and Pipe Fittings - General

1.4 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.
- B. Submit wording of nameplates with submittals.
- C. Submit list of all products incorporated in this section.

1.5 REFERENCES

- A. Comply with ANSI A13.1
- B. USAS Code B31.8
- C. NTSB-PSS-73-1
- D. AGA
- E. API

1.6 DESCRIPTION OF WORK

- A. Provide signs for the following equipment identification:
 - 1. Water Heaters
 - 2. Piping
 - 3. Pumps
 - 4. Valves

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Seton
- B. Brady

2.2 EQUIPMENT LABELS

- A. Type:
 - 1. Engraving-Stock, melamine plastic laminate, 3 layer.
 - a. Thickness:
 - (1) Less than 25 square inches: 1/16 inch
 - (2) 25 square inches or more: 1/8 inch
- B. Color:
 - 1. Black
- C. Conform to FS L-P-287

2.3 LETTERING

- A. Style:
 - 1. Engraved standard print, unless otherwise indicated.
- B. Size:
 - 1. 3/16 inch to 1/4 inch
- C. Color:
 - 1. White letters, black background

2.4 SIGN INFORMATION

- A. Plumbing Equipment:
 - 1. Unit mark from Drawings/Owner
 - 2. Voltage - Phase
 - 3. Manufacturer and Model Number

2.5 NAMEPLATE FASTENERS

- A. Securely attach nameplates to equipment with non-corroding stainless steel screws.
- B. Non-corroding pop rivets are acceptable.
- C. Stick-ons or adhesives will not be allowed.

2.6 PIPING AND CONTROL DIAGRAM SIGNS

- A. Material:
 - 1. 1/4 inch acrylic cover and backing screwed together with brass screw/bolts.
 - 2. Size:
 - a. Minimum:
 - (1) 12" x 17"
 - b. Maximum:
 - (1) 24" x 36"

- B. Provide a diagram in each mechanical room similar to the diagrams shown on the plans, and/or as required for the area served.
- C. Provide pipe markers with the following features.
 - 1. Letters from 1/2" to 3-1/2":
 - a. Size letters to afford readability from the appropriate viewing position.
 - 2. Repeated and reversed words for viewing from 360° around pipe.
 - 3. Self-clinging, coiled markers that snap into place around pipe and do not require any other securement.
 - 4. Integral directional arrows.
- D. Letters on Field:
 - 1. Identify the specific material conveyed, e.g., "Domestic Cold Water", "Domestic Hot Water", etc.
- E. Model:
 - 1. Less than 3/4":
 - a. Tags, same as Paragraph. Piping System Devices, color codes for hazard.
 - 2. 3/4" up to 6":
 - a. Seton Setmark SNA snap-on.
 - 3. Over 6":
 - a. Seton Setmark STR strap-on, with stainless steel spring straps.
 - 4. Use Seton Ultra-Mark for outdoor use.
- F. Piping System Devices (Valves, Thermometers, Pressure Gages, etc., and Pipe Less Than 3/4"):
 - 1. Identify with the following:
 - a. Tags:
 - (1) Not less than 1-1/2 inch brass or aluminum tags, round, square, or octagonal.
 - b. Stamp tags with minimum 1/2" high descriptive characters, 1/2" high numbers with black enamel-filled indentations.
- G. Attachment:
 - 1. Stainless steel or solid brass jack chain; Seton JA16, or stainless steel or brass "S" hooks
- H. Underground Warning Tapes:
 - 1. Provide materials that meet the codes or have the approvals listed below:
 - a. Office of Pipeline Safety Regulation, USAS Code B31.8.
 - b. GSA Public Building Service Guide Specification.
 - c. National Transportation Safety Board Report NTSB-PSS-73-1.
 - d. AGA Report 72-D-56.
 - e. API Report API RP 1109.
 - 2. Material:
 - a. Plastic, continuous tape, color-coded, marked for hazard.
 - b. For Non-metallic Piping System:
 - (1) Aluminum foil core encased in plastic.
 - c. Metallic Piping:
 - (1) Plastic tape.
 - 3. Color:
 - a. Colored (not printed color) plastic, coded for material conveyed by piping.
 - 4. Width:
 - a. As scheduled for piping system burial depth.
 - 5. Legend:
 - a. "Caution [System Name] Line Buried Below".

6. Tape Colors:

Utility	Color
Natural Gas, Oil, Dangerous Materials	Hi Visibility Safety Yellow
Communications	Safety Alert Orange
Water Systems	Safety Precaution Blue
Sewer Systems	Safety Green

7. Model:

- a. Metallic Piping System: Seton Polyethylene Tape.
- b. Non-Metallic Piping System: Seton Metallic Detection Tape.

I. Underground Gas Piping:

1. Attach No. 18 gauge copper tracer wire to the piping and terminate above grade at each end.

J. Pipeline Markers for Pipe Beneath Pavement and Slabs:

1. Minimum 2" round, square, or octagonal, same as specified in Subparagraph: Piping System Devices.
2. Attachment:
 - a. 1-1/2" screw, bolted to tag as anchor.
 - b. Anchor Setting Compound: Epoxy or epoxy grout, compatible with the pavement.

PART 3 EXECUTION

3.1 GENERAL

- A. Contractor shall verify room numbers with Owner before nameplates are fabricated.
- B. The following shall be permanently and clearly identified:
 1. Each valve and pump.
 2. Each valve whose service and/or duty is not immediately apparent.

3.2 INSTALLATION

- A. Install signs on non-removable panels. Attach to equipment with pop rivets or stainless steel screws.
- B. Mount in an easily visible location.
- C. All labeling identification shall conform to final room numbers. Coordinate with General Contractor, Architect and Owner to secure construction room numbers.
- D. Provide all additional signage required by local authority at no cost to the Owner.
- E. Complete installation in accordance with ANSI A13.1 and manufacturer's installation instructions and with the Drawings. Fasten each unit securely in place with stainless steel screws.
- F. Equipment Labeling:
 1. Install on scheduled items of equipment, including the following:
 - a. Water heaters
 - b. Pumps
 - c. Control panels and major control components
 - d. Other items of equipment

- e. Include Mark Number and descriptive name from Drawing and Specification schedules
- f. Attach with corrosion resistant, stainless steel screws or pop rivets
- g. Install 1/2" diameter adhesive marker (color to be approved by Architect), and apply to T-bar below any mechanical equipment and fire dampers above lay-in ceiling.
- 2. Spacing:
 - a. Where pipe passes through walls, floors, and other barriers.
 - b. In Tunnel Vaults and Equipment Rooms:
 - (1) Maximum spacing, 10 feet; closer where piping is congested, and where piping continuity is obscured from view.
 - c. Piping in Tunnels:
 - (1) Maximum spacing 100 feet
 - d. Other Places:
 - (1) Maximum spacing 50 feet
- G. Piping System Color Coding:
 - 1. Designate for painter the following:
 - a. Types of piping services
 - b. Direction of flow
 - c. Other information required for proper identification.
- H. Surfaces to be Painted:
 - 1. Bare piping
 - 2. Insulation covering of insulated piping
- I. Paint according to the following schedule:

System	Pastel Color
Exposed Domestic Cold Water	Blue
Waste and Vent	None
Exposed Gas Piping	Black
- J. Piping System Devices (Valves, Thermometers, Pressure Gages, etc.):
 - 1. Identify with the following information:
 - a. System
 - b. Device number
 - c. Device Function
 - 2. Device Chart:
 - a. Key devices to device chart
 - b. Give complete description of device function and system.
- K. Key devices to drawings as follows:
 - 1. Floor plans
 - 2. Schematic drawings of piping systems
- L. Underground Warning Tapes:
 - 1. Tape Widths:

Piping Burial Depth	Tape Width
10"	2"
20"	3"
27"	6"
30"	9"
40"	12"
50" or more	18"

- M. Recommended Tape Bury Depth:
 - 1. Minimum Depth:
 - a. 6".
 - 2. Distance Between Pipe and Tape:
 - a. Minimum 12".
 - 3. Maximum Depth:
 - a. 12".
- N. Tie tape to pipe where pipe leaves the ground.
- O. Pipeline Markers for Pipe Beneath Pavement and Slabs.
 - 1. Location:
 - a. Accuracy:
 - (1) Plus or minus 6" from piping centerline.
 - b. Flat Edge Pavement and Slabs:
 - (1) Set within 6" of pavement or slab edge.
 - c. Concrete Curbs:
 - (1) Set in top of curb.
 - d. Spacing:
 - (1) Each change in direction, each edge of pavement or slab, maximum spacing of 100'.
- P. Legend:
 - 1. Same as tags plus an engraved or stamped line; set marker with line parallel to buried line.
- Q. Attachment:
 - 1. Drill hole for anchor bolt, full depth of bolt plus 1/2"; set full tag and bolt in epoxy, flush with pavement or slab.

END OF SECTION

SECTION 22 07 20

PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Fiberglass insulation
 - 1. Applications:
 - a. Above ground domestic cold water
 - b. Horizontal portions of waste lines above grade which receive condensate from air handling units
 - c. Condensate drain lines
 - d. Domestic hot water piping

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 11 17 - Domestic Water Piping and Appurtenances
- C. Section 22 13 17 - Soil, Waste, and Sanitary Drain Piping, Vent Piping, and Appurtenances

1.4 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 22 00 10, General Conditions, and Division 01.
 - 2. Submit product data indicating typical catalog of information.
 - 3. Submit product data sheets indicating dimensions, general assembly, and ratings.
 - 4. Submit manufacturer's installation instructions and method of application.

1.5 REFERENCES

- A. Refer to Section 22 00 10 for complete names of references identified in this section.

ASTM E 84	Fire and Smoke Ratings
ASTM C 547	Standard Specifications for Mineral Fiber Pipe Insulation
ASTM C 585	Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
ASTM C 795	Standard Specifications for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
NFPA 255	Surface Burning Characteristics of Building Materials
UL 723	Composite Surface Burning Characteristics

1.6 DEFINITIONS

- A. Concealed:
 - 1. Hidden from sight as in trenches, chases, furred spaces, walls, pipe shafts, or hung ceilings.
- B. Exposed:
 - 1. Not "concealed" as defined above. Normally open and visible to building occupants (such as gymnasiums).

1.7 QUALITY ASSURANCE

- A. Fire Hazard Rating:
 - 1. All insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E84, NFPA 255 and UL 723.
 - 2. These ratings must be tested on the composite of insulation, jacket or facing, and adhesive.
 - 3. Components such as adhesives, mastics and cements must meet the same individual ratings as minimum requirements.
- B. Quality Controls:
 - 1. All insulation shall be the product of reputable manufacturers.
 - 2. All insulation shall be applied by mechanics skilled in the use of various materials, and in the employ of a concern regularly engaged in the insulating business. Submit qualifications of insulator with insulation submittals.
 - 3. The materials shall be applied in accordance with the special materials as required by these specifications and by the manufacturer standards.
 - 4. Poor workmanship or appearance will be cause for rejection.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Armstrong
- B. Johns Manville
- C. Knauf
- D. Owens/Corning

2.2 GENERAL

- A. Molded pipe insulation shall be manufactured to meet ASTM C 585 and ASTM C 547 for sizes required for the particular system and shall be suitable for installation on piping systems defined.

2.3 ABOVE GROUND PIPE INSULATION

- A. Density:
 - 1. 3/4 lb. per cubic foot.
- B. Minimum R value:
 - 1. 4.0 per inch of thickness.

- C. Construction:
 - 1. Fiberglass with factory-applied, all service reinforced vapor barrier jacket having integral laminated aluminum vapor barrier and double adhesive self-sealing lap.
- D. Thickness:
 - 1. Domestic Cold Water Piping:
 - a. Interior walls and above ceilings:
 - (1) 1/2 inch
 - b. Exterior walls:
 - (1) 1 inch
 - 2. Condensate Lines:
 - a. 1/2 inch
 - 3. Waste Lines Which Receive Condensate:
 - a. 1/2 inch
 - 4. Domestic Hot Water Piping (Up to 169° F):
 - a. 2" diameter and less:
 - (1) Interior walls and above ceilings: 1 inch
 - (2) Exterior walls: 1 inch
 - b. 1¼ inch diameter and larger:
 - (1) 1 inch
 - c. Outdoor:
 - (1) 2 inch
- E. Make/Model:
 - 1. Owens Corning ASJ/SSL-II

2.4 FLANGE, VALVE AND FITTING INSULATION

- A. Exposed Piping:
 - 1. Provide molded or mitered covers with full thickness matching adjacent covering.
 - 2. Finish with white glass, reinforced white vapor barrier coating.
- B. 2½ Inch Diameter and Larger Concealed Piping:
 - 1. Insulate fittings and valves with molded or mitered fitting covers.
 - 2. Finish with white vapor barrier coating reinforced with white 10" x 10" reinforced mesh.
- C. 2 Inch Diameter and Smaller Concealed Piping:
 - 1. Insulate fittings and valves with mineral wool and insulating cement to a thickness equal to or greater than adjoining straight pipe.
 - 2. Molded or mitered fittings finished with white vapor barrier coating reinforced with reinforced mesh may be provided.
- D. Underground Piping (hot water only):
 - 1. Provide mitered covers with full thickness matching adjacent covering.
 - 2. Field fabricated miter joints are not acceptable.
 - 3. No insulation is required on underground domestic cold water piping.
- E. Outdoor Piping:
 - 1. Metal jacketing shall be 0.016" minimum aluminum or stainless steel with moisture barrier, secured in accordance with jacket manufacturer's recommendations.
 - 2. Use preformed fitting covers matching jacket used on straight pipe, with all joints sealed with metal jacketing sealant.

2.5 SEALANT, ADHESIVE, AND FINISH

- A. Sealant:
 - 1. Manufacturers:
 - a. Foster 95-44
 - b. Childers CP-76
 - 2. Usage:
 - a. Valve Covers
 - b. Anchors
 - c. Hangers
 - d. Metal Jacketing
 - e. Flashing Penetrations
- B. Adhesive:
 - 1. Manufacturer:
 - a. Foster 85-20/85-60 and Childers CP-127
 - 2. Usage:
 - a. Longitudinal laps of the vapor barrier jacket
 - b. Butt joint covers.
- C. Weather Barrier Mastic
 - 1. Manufacturers:
 - a. Foster 46-50
 - b. Childers CP-10
 - 2. Usage:
 - a. Used on above ambient piping/duct to protect insulation from weather.
 - b. Use in conjunction with reinforcing mesh.
- D. Vapor Barrier Coating:
 - 1. Manufacturer:
 - a. Foster 30-33 Vapor Out
 - b. Childers CP-33 Chil Out
 - 2. Usage:
 - a. Glass fabric reinforcement.
- E. Reinforcing Mesh
 - 1. Manufacturers:
 - a. Foster Mast Afab
 - b. Childers Chil-glass #10

2.6 INSULATION SHIELD

- A. Field-fabricated:
 - 1. Material:
 - a. High-density fiberglass insulation
 - 2. Construction:
 - a. Insulation to support the bearing area at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference. Adhere metal shield to insulation so that metal will not slide with respect to insulation.
 - 3. Schedule:
 - a. 3" and smaller pipe diameter:
 - (1) 12 inch insulated section, 18 gauge metal shield
 - b. Greater than 3" pipe diameter:
 - (1) 12 inch insulated section, 16 gauge metal shield

- B. Factory-made:
 - 1. Manufacturer:
 - a. Pipe Shields, Inc. or equal.
 - 2. Type:
 - a. Proper shield for service and pipe span.
 - 3. Construction:
 - a. Extend insulation at least 1 inch beyond metal.
- C. Insulation shall not compress at hanger.

PART 3 EXECUTION

3.1 SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.
- C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 PROPERTIES

- A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.
- B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.3 INSTALLATION

- A. General:
 - 1. Install all insulation materials and accessories in accordance with manufacturer's published instruction and recognized industry practices to ensure that it will serve its intended purpose.
 - 2. Install insulation on piping subsequent to installation of heat tracing, painting, and acceptance tests.
 - 3. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
 - 4. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable vapor barrier coating to maintain vapor barrier integrity.

3.4 PIPE

- A. Insulation size shall match pipe size.
- B. Insulation to be continuous through wall and ceiling penetrations.
- C. Apply insulation to clean, dry pipes.
- D. Butt insulation joints firmly together and apply butt strip. All pipe insulation ends shall be tapered and sealed.
- E. Butt pipe insulation against hanger inserts. Seal jacketing according to type used.
- F. Seal longitudinal laps and butt strips with sealant in addition to the self-sealing laps.
- G. Seal joints with adhesive and staple at 2" O.C. with outwardly clenching staples.
- H. Seal all joints with vapor barrier coating.

3.5 VALVES, FLANGES, AND FITTINGS

- A. Insulate all valves, flanges, and fittings with covers secured with Velcro with equivalent thickness and composition installation on straight pipes.
- B. Finish with 1/4 inch layer of Foster 30-33 or Childers CP-33 reinforced with reinforcing mesh.
- C. Factory made covers equal to Schuller Zeston are acceptable.

3.6 CONTROL VALVE COVERS

- A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
- B. Seal covers to valve insulation properly with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve.
- C. Finish valve cover with glass cloth and two coats of vapor barrier coating.
- D. Factory made covers are acceptable. Provide submittal.

3.7 REPAIRS AND REPLACEMENT

- A. Replace any insulation that gets wet, whether now dry or not.
- B. Repair any damage caused by condensation due to improper insulating.

3.8 EXPOSED PIPING

- A. Insulate piping exposed to view with a glass fabric or canvas jacket with brushed on coating to present a smooth finished look to a height of 8 ft. A.F.F. or use PVC cover.

3.9 OUTDOOR PIPING

- A. Metal jacket shall be applied per manufacturer's recommendations. Longitudinal joints shall be applied so they will shed water completely and be sealed completely with 1/8" bead of

metal jacketing sealant under each lap. Circumferential joints shall be closed using preformed butt strips in accordance with manufacturer's recommendations.

3.10 SHIELDS

- A. Metal jacketing shall be 0.016-inch minimum aluminum or stainless steel with moisture barrier, secured in accordance with jacket manufacturer's recommendations. Use bands and seals of the same material. Use preformed fitting covers matching jacket used on straight pipe, with all joints weather sealed with 1/8" bead of metal jacketing sealant under each lap.

3.11 SHIELDS AND HANGERS

- A. Piping hangers or anchors are not be in direct contact with pipe. Hangers are to on the outside of the insulation with pipe shields at each hanger.
- B. At the location of hangers or supports for pipes run above ground and finished with a vapor seal insulation, provide rigid sections of cork, high density fiberglass, Foamglas, calcium silicate or high density polyurethane, the same thickness as adjacent insulating material to adequately support the pipe without compression of the insulating material and cover with a vapor seal that is bonded to the adjacent insulation as described for fittings in the lines. Wood inserts shall not be allowed. Hangers and supports for piping insulation to receive a vapor barrier shall be installed exterior to the insulation.
- C. Material Changes:
 - 1. Wherever there is a change in materials on lines that are vapor sealed, apply a suitable adhesive that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.
- D. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe.
- E. Take care to avoid puncturing the vapor seal.
- F. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.12 FIELD QUALITY ASSURANCE

- A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.13 PROTECTION

- A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.
- B. The insulation contractor shall advise the general and/or the mechanical/plumbing contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

END OF SECTION

SECTION 22 08 00

COMMISSIONING OF PLUMBING SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
- B. Division 01 section 'Building Systems Commissioning'.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "Building Systems Commissioning" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "Building Systems Commissioning" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "Building Systems Commissioning" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "Building Systems Commissioning" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "Building Systems Commissioning" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the plumbing contractor of Division 22 shall ultimately be responsible for all standard testing equipment for the plumbing systems and controls systems in Division 22. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 – EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Functional Testing Forms for all commissioned components, equipment, and systems
- B. Red-lined Drawings:
 - 1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 - 2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 - 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
 - 4. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data:
 - 1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
 - 2. The CxA will review the O&M literature once for conformance to project requirements.
 - 3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

- D. Systems manual requirements:
 - 1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 - 2. The GC shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Schematics
 - b. Verified Record Drawings
 - c. Test Results (not otherwise included in Cx Record)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
 - 3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.
 - 4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner.
- G. Update schedule as required throughout the construction period.
- H. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- I. Assist the CxA in all verification and functional performance tests.
- J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- L. Participate in, and schedule vendors and contractors to participate in the training sessions.

- M. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - 1. Service Water Heating Systems and components such as hot water heaters, circulation pumps and controls.
- N. The equipment supplier shall document the performance of his equipment.
- O. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
- P. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- Q. Equipment Suppliers
 - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 - 2. Assist in equipment testing per agreements with contractors.
 - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
- R. Refer to Division 01 Section "Building Systems Commissioning" for additional Contractor responsibilities.

3.3 OWNER'S RESPONSIBILITIES

- A. Refer to Division 01 Section "Building Systems Commissioning" for Owner's Responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01 Section "Building Systems Commissioning" for Design Professional's Responsibilities.

3.5 CXA'S RESPONSIBILITIES

- A. Refer to Division 01 Section "Building Systems Commissioning" for CxA's Responsibilities.

3.6 TESTING PREPARATION

- A. Certify in writing to the CxA that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include the service water heating system.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.8 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Functional Performance Tests: The CxA may modify these procedures during the Construction Phase once all systems are known and all required documentation has been provided.
- B. Plumbing Instrumentation and Control System Testing: Assist the CxA with preparation of testing plans.

3.9 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section “Building Systems Commissioning” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.10 APPROVAL

- A. Refer to Division 01 Section “Building Systems Commissioning” for approval procedures.

3.11 DEFERRED TESTING

- A. Refer to Division 01 Section “Building Systems Commissioning” for requirements pertaining to deferred testing.

3.12 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section “Building Systems Commissioning” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

END OF SECTION

SECTION 22 11 17

DOMESTIC WATER PIPING AND APPURTENANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Domestic hot water piping.
- B. Domestic cold water piping.

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 05 24 - Valves - General
- C. Section 22 05 30 - Pipe and Pipe Fittings - General
- D. Section 22 33 34 - Access Doors
- E. Section 22 40 01 - Plumbing Fixtures and Fixture Carriers

1.4 REFERENCES

- A. ASTM 763 - Standard Specification for Copper Alloy Sand Castings for Valve Applications
- B. ASTM 61 - Standard Specification for Steam or Valve Bronze Castings
- C. ASTM C27450 - Standard Specification for Brass Rod, Bar & Shapes
- D. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges & Pipe Fittings
- E. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications
- F. ASTM - American Society of Testing Materials
- G. ASTM B813-00e1 - Standard Specification for Liquid & Paste Fluxes for Soldering of Copper & Copper Alloy Tube
- H. ASTM B828-02 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- I. ASTM B88-02 - Standard Specification for Seamless Copper Water Tube
- J. PDI - Plumbing & Drainage Institute
- K. NSF/ANSI Standard 61

1.5 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.
- B. Submit product data sheets.

PART 2 PRODUCTS

2.1 UNDERGROUND PIPING

- A. Type:
 - 1. 2 Inch Diameter and Smaller:
 - a. Type "L" soft drawn commercially pure copper
 - 2. 2½ Inch Diameter:
 - a. Type "L" hard drawn commercially pure copper
 - 3. 3 Inch Diameter or Larger:
 - a. Type "L" hard drawn commercially pure copper
- B. All copper meets ASTM B88 Standards.

2.2 UNDER SLAB PIPING

- A. Type:
 - 1. 2 Inch Diameter and Smaller:
 - a. Type "K" soft drawn commercially pure copper
 - 2. 2½ Inch Diameter and Larger:
 - a. Type "K" hard drawn commercially pure copper
- B. No joints will be permitted in piping runs beneath concrete slabs. All joints shall be made in accessible areas above the slab (behind access doors in walls, in mechanical closets, etc.).
- C. All copper meets ASTM B88 Standards.

2.3 INTERIOR PIPING

- A. Type:
 - 1. Type "L" hard drawn commercially pure copper
- B. All copper meets ASTM B88 Standards.

2.4 PIPE FITTINGS

- A. Copper Piping:
 - 1. Unions:
 - a. 150 lb. standard, 300 lb. water-oil-gas service copper with ground joints.
- B. Dissimilar Metal:
 - 1. Di-Electric Unions

2.5 PIPE JOINTS

- A. Copper Piping:
 - 1. Type: Solder fittings
 - a. Solid string, hard solder

- b. Wire, hard solder
- c. Cored solder will not be allowed
- 2. Type: Press-connect fittings
 - a. Copper and copper alloy fittings with EPDM elastomeric sealing element.
 - b. Unpressed fittings shall leak and not hold pressure.
- 3. Approved Manufacturers:
 - a. Viega ProPress
 - b. Nibco
 - c. Mueller Industries Streamline PRS
- 4. Material:
 - a. Solder (1½" and Smaller):
 - (1) 95-1/2% tin, 4% copper and 1/2% silver
 - b. Solder (2" and Larger):
 - (1) "SILFOS15", 15% silver, 80% copper, 5% phosphorous
 - c. Flux:
 - (1) Non-corrosive, lead-free paste
- 5. Use a cast brass adapter when connecting copper pipe to screwed brass pipe.
- 6. Brand:
 - a. Silvabrite or similar brand

B. Conform to ASTM B813 and ASTM B828.

2.6 VALVES

- A. Type:
 - 1. Check Valves:
 - a. 125 lb. bronze check valve with "Buna-N" disc.
 - 2. Ball Valves:
 - a. 150 psi, bronze 1/4 turn ball valve with full port.
 - b. 300 psi, bronze 1/4 turn ball valve with full port. ASTM 61
 - c. 125 psi, lead free dezincification resistant arsenical brass ¼ turn ball valve with full port, C46500 or CW 511L, ASTM 763
 - 3. Temperature and Pressure Relief Valves:
 - a. ASME rated valve
 - 4. Gate Valves:
 - a. 125 lb. rising stem, double-disc bronze gate valves larger than 3 inches.
 - 5. Water Main Valves:
 - a. 150 lb. AWWA valve.
 - 6. Pressure Reducing Valves
 - a. 300 lb. bronze sealed spring cage, strainer
 - 7. Cast Iron: ASTM A126, Class B
 - 8. Cast Carbon Steel: ASTM A216, Grade WCB
 - 9. Forged Carbon Steel: ASTM A105, Grade II
- B. Manufacturers:
 - 1. Apollo
 - 2. Crane
 - 3. Grinnell
 - 4. Jenkins
 - 5. Jomar, T-100NGDZ
 - 6. Kennedy
 - 7. Milwaukee Valve Company
 - 8. Nibco
 - 9. Stockham
 - 10. Walworth
 - 11. Watts

12. Hammond

- C. Provide valves where required to adequately control and isolate the various domestic water piping systems.
- D. Provide valves at the connection point of all equipment.
- E. Provide Di-Electric Unions at connection of dissimilar metal.

2.7 CONSTRUCTION

- A. Provide valves designed for repacking under pressure when fully opened.
- B. Equip with packing suitable for intended service.
- C. Furnish with gland followers.
- D. Provide valves rated greater than the design temperature and pressure for the intended system.
- E. All domestic cold water and hot water valves 2" and less shall be full port ball valves.

2.8 WATER HAMMER ARRESTORS

- A. Water Hammer Protective Devices:
 - 1. Usage:
 - a. Provide on hot and cold water supply lines. Locate between last two flush/solenoid valves on supply lines or per manufacturer's recommendations.
 - b. In single toilets locate within 3-feet of fixture or per manufacturer's recommendation.
 - 2. Type:
 - a. As recommended by the manufacturer for the particular application.
 - b. Locate arrestor on shop drawings with size.
 - 3. Manufacturer/Model:
 - a. Wade "Shokstop"
 - b. Sioux Chief "Hydra-Rester"
 - c. PPP "SC Series"
 - d. Mifab "MWH Series"

2.9 FREEZE PROTECTION

- A. Heat Trace Tape:
 - 1. Usage:
 - a. Provide on hot and cold water supply lines where freezing of the piping is a concern.
 - 2. Type:
 - a. Self-regulating heating cable, 5 watt per liner foot. Provide control panel and all necessary controls and wiring.
 - 3. Manufacturer/Model:
 - a. Raychem XL-Trace

PART 3 EXECUTION

3.1 INSTALLATION

- A. All products to comply with NSF/ANSI Standard 61.

- B. Install in accordance with the plans and Section 22 05 30.
- C. Drainage:
 - 1. Minimum Slope:
 - a. 1/8 inch per 10 feet.
 - 2. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to higher level.
 - 3. Slope branches to drain toward mains or risers.
 - 4. Terminate low points of risers with drain valve piped to nearest hub or floor drain unless otherwise indicated.
- D. Water Hammer Arrestors:
 - 1. Install in accordance with PDI Standard WH201.

3.2 VALVES

- A. All valves, trap primers, etc. that are located behind access doors shall be located directly behind door and within 24" of plane of door.

3.3 INSTALLATION

- A. Install valves and stops in accessible locations.
- B. Provide where shown or as required to make system complete and readily maintained.
- C. Provide pressure reducing valve on domestic water main where hydrostatic pressure exceeds 80 psi.
- D. Isolation valves shall be located:
 - 1. Restroom Gang – Behind an 18" x 18" stainless steel access panel with screwdriver operated latch located in the Boy's or Men's restroom.
 - 2. Individual (private) Restrooms – Behind an 18" x 18" stainless steel access panel with screwdriver operated latch.
 - 3. Individual Fixtures – Above the ceiling within 12" of the water risers where ceiling is accessible. Above the ceiling behind ceiling access panel within 12" of the water riser where ceiling is not accessible.
 - 4. Isolation valves on the domestic cold water shall be provided in corridors to allow isolation of buildings wings, sections, areas.
- E. Press fitting manufacturer shall provide a duplicate set of all tools required to maintain and/ or modify press fittings. Required tools are to be given to the owner. One set of tools shall be provided for each campus.

3.4 FIELD QUALITY CONTROL

- A. Properly test water distribution systems with hydrostatic pressure in accordance with local plumbing code.
- B. Do not install trap primers, flush valves or other pressure sensitive devices until all tests are completed.
- C. Repair all leaks in pipes, fittings and accessories during this test period.
- D. Repeat hydrostatic test until no leaks are found for an entire 8 hour period.

- E. Make joints in accordance with ASTM B828.

3.5 STERILIZATION

- A. Solution:
1. Strength:
 - a. Minimum 50 parts per million
 2. Agents:
 - a. Liquid Chlorine:
 - (1) Conform to U.S. Army Specification #4-1
 - b. Calcium Hydrochloride:
 - (1) Federal Specification O-C-114
 - c. Chlorinated Lime:
 - (1) Federal Specification O-C-114
- B. Procedure:
1. Perform sterilization after testing has been satisfactorily completed.
 2. Pump solution into a 1/4 inch opening provided in the water main next to the water meter.
 3. Conduct the sterilization process under the direction of the local health department.
 4. After sterilization, flush the system with clean water until the residual chlorine content is less than 3 ppm.
 5. After flushing, the local health department will test and verify the cleanliness of the system.

3.6 PLUMBING SCHEDULE

- A. Minimum Size:
1. Water Closets (flush valve):
 - a. 1-1/4" cold water
 2. Urinals:
 - a. 3/4" cold water
 3. Sinks:
 - a. 1/2" cold water, 1/2" hot water
 4. Mop & Service Sinks:
 - a. 1/2" cold water, 1/2" hot water
 5. Hose Bibbs:
 - a. 3/4" cold water
 6. Drinking Fountains:
 - a. 1/2" cold water
 7. Lavatories:
 - a. 1/2" cold water, 1/2" hot water

END OF SECTION

SECTION 22 13 17

SOIL, WASTE AND SANITARY DRAIN PIPING, VENT PIPING, AND APPURTENANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Drain and vent piping within the building and underground laterals.

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 11 17 - Domestic Water Piping and Appurtenances
- C. Section 22 13 18 - Condensate Piping
- D. Section 22 33 34 - Access Doors
- E. Section 22 40 01 - Plumbing Fixtures and Fixture Carriers
- F. Section 22 66 54 - Chemical Waste and Vent Piping

1.4 REFERENCES

- A. Refer to Section 22 00 10 for complete names of references identified in this section.
 - Commercial Standard CS-188-59
 - ASTM D-2665-04 Standard Specifications for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste & Vent Pipe & Fittings
 - ASTM A74-04 Standard Specification for Cast Iron Soil Pipe & Fittings

1.5 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.
- B. Submit product data on pipe, pipe fittings, trap primers, covers, cleanouts, etc.

PART 2 PRODUCTS

2.1 DRAIN PIPE AND FITTINGS

- A. Material:
 - 1. Schedule 40 PVC pipe and fittings conform to ASTM D-2665.
 - 2. "Foam Core PVC" not allowed.
 - 3. Schedule 40 CPVC piping and fittings conform to ASTM F-441.
- B. Conform to ASTM A74, ASTM 888 and ASTM C564.

2.2 VENT PIPE AND FITTINGS

- A. Material:
 - 1. Schedule 40 PVC pipe and fittings conform to ASTM D-2665.
 - 2. Schedule 40 CPVC piping and fittings conform to ASTM F-441.
- B. Comply with ASTM A74 and ASTM C564.

2.3 CLEANOUTS

- A. Size:
 - 1. Identical with the line size up to a maximum diameter of 4 inches.
- B. Type:
 - 1. Compatible with the surrounding floor/wall.
- C. Manufacturer:
 - 1. Jay R. Smith
 - 2. Josam
 - 3. Mifab
 - 4. Sioux Chief
 - 5. Wade W-6000
 - 6. Watts
 - 7. Zurn

2.4 PLUGS

- A. Wade 8590, Tapped brass cleanout plug only. PVC plugs not allowed.
- B. Applications:
 - 1. Each change in direction of soil lines
 - 2. End of each continuous waste line
 - 3. Foot of each riser within the building
 - 4. 50 ft. intervals in interior horizontal lines
- C. Construction: Secure covers with vandal-proof screws
- D. Finished Floors:
 - 1. Covers: Chromium plated, flush mounted, cast bronze with scoriated top surface.
- E. Walls/Painted Surfaces:
 - 1. Covers:
 - a. Furnish chromium plated covers.
- F. Exterior Locations:
 - 1. Traffic Areas:
 - a. Covers: Flush mounted, cast bronze covers with scoriated top surface
 - 2. Non-Traffic Areas:
 - a. Encase in a 14" x 14" x 6" concrete pad
 - b. Manufacturer/Model:
 - (1) Wade W-8500 series

2.5 CLOSET FLANGE

- A. Size: 4" to match sanitary sewer piping.

- B. Type:
 - 1. PVC or cast iron to match sanitary sewer piping.
 - 2. PVC flanges to be provided with stainless steel ring for reinforcement.
 - 3. Offset toilet flanges are not allowed.
- C. Manufacturer
 - 1. Oatley or equal

2.6 TRAP GUARDS

- A. Trap guards manufactured by Proset are to be installed at all floor drains, floor sinks (Series TG).

2.7 SAND BACKFILL/EMBEDMENT

- A. Sand for embedment shall be a free flowing material which contains no clay, is reasonably free from organic material and does not form a muck or mud when wet. The gradation shall be such that a minimum of 95% is retained on a #100 sieve. The P.I. of the soil fraction passing the No. 40 sieve shall not be greater than 5.

2.8 EXPOSED INDIRECT WASTE LINES IN KITCHENS AND CONCESSIONS:

- A. All exposed indirect waste lines in kitchens and concessions to be DWV copper material. All joints to be soldered and turned down with elbow above floor sink or hub drain (discharge below elbow to be cut at 45-degree angle).

2.9 VENT FILTERS

- A. Provide vent filters equal to Studor Maxi-Filtra on all vent terminations.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Location:
 - 1. Install a 12-gauge copper tracer wire on all underground sewers outside of building.
- B. Slope:
 - 1. Desired: 1/4 inch per foot
 - 2. Minimum:
 - a. 1/8 inch per foot for diameter of 4 inch and larger if approved by local authority and it is impractical to use 1/4 inch per foot.
- C. Drain Pipe and Fittings:
 - 1. Reduction fittings:
 - a. Use to connect two pipes of different diameter.
 - 2. Directional changes:
 - a. Use 45 degree wyes, long sweep quarter bends, and sixth, eighth, and sixteenth bends. Sanitary tees may be used on vertical stacks. Use long sweeps at the base of risers.
 - b. Embed pipe on sand cushion approximately 2 pipe diameters below (minimum 4") and at least one diameter on each side and top in trench.
 - c. No hub couplings of any type cannot be used underground.

- D. In kitchens install a minimum of 20-feet of Schedule 40 CPVC or Schedule 40 cast iron pipe and fittings from dishwasher, braising pans, and steamer discharges. This includes all connected piping to a point 20-feet from initial discharge.
- E. Traps:
 - 1. Provide at each fixture unless a trap is built into the fixture.
 - 2. Provide a deep seal trap and trap primers at each floor drain and hub drain.
 - 3. Place traps so that the discharge from any fixture will pass through only one trap before reaching a building drain.
 - 4. Place each trap as near to the fixture as possible. Do not exceed the distances stated in the governing codes up to a maximum of 8 feet.
- F. Trap Guards:
 - 1. Install per manufacturer's recommendations.
- G. Trap Primers:
 - 1. Provide trap primers at all floor drains, floor sinks and hub drains on entire project.
 - 2. Provide unions on each side of trap primer for service.
 - 3. Manufacturer shall provide field start-up and review of installation on trap primers.
- H. Hub Drains:
 - 1. Install with the top of the hub 1/2 inch above the finished floor, unless otherwise shown on the drawings.
- I. Cleanouts:
 - 1. Install so that they open in a direction opposite to the pipe flow or at a right angle.
 - 2. At all wall cleanouts install tapped brass cleanout plug behind wall escutcheons.
 - 3. Install vertically above the flow line of the pipe for "wye" branch and end-of-line cleanouts.
 - 4. Place cleanouts above the floors in pipe chases so that they will be accessible through doors or bring through a wall and provide with flush covers.
 - 5. Set cleanouts flush in floor slabs.
 - 6. Place cleanouts in accessible locations. Exact locations of each shall be approved by the Architect before installation. Locate all cleanouts within 2-feet of access door or cover.
- J. Plugs:
 - 1. Install temporary plugs in all open sanitary drain pipes during construction to prevent any foreign objects from entering the pipe.
 - 2. All floor drains to have plugs until substantial completion.
- K. Vent Piping:
 - 1. Connections:
 - a. Connect two or more vents together and extend as one vent through the roof, where practical.
 - b. Make vent and waste connections to stacks by using 45 degree wyes, long sweep quarter bends, sixth, eighth, or sixteenth bends. Sanitary tees may be used on the vertical stacks.
 - 2. Flashing:
 - a. Use minimum 10-inch square, 4-pound lead flashing.
 - b. Flange the flashing to the lead sleeve.
 - c. Extend the flashing up and around the vent pipe.
 - d. Turn the flashing down inside the pipe at least 2 inches to make an absolutely watertight joint.
 - e. For single-ply rooftop systems, flash according to the roofing specifications.
 - 3. Location:
 - a. Do not locate any vent within 15 feet of an outside air intake.

4. Mop Sinks:
 - a. Mop sinks to be installed after substantial completion.
5. Termination:
 - a. 12 inch above roof deck or 2 inch above parapet, whichever is greater.

3.2 TESTING

- A. Temporarily plug sanitary drain piping.
- B. Fill the pipes with water.
- C. Test the system in sections so that no section has a pressure less than 10 feet of water.
- D. If the level of water has been decreased by leakage after a 24-hour period, then locate and repair all leaks.
- E. Repeat the test until there is no perceptible decrease in the water level over a 24-hour period.
- F. Sewer Pressurization Test:
 1. Provide smoke pressure test after slab/floor is poured and again at substantial completion.
 2. All smoke test on the sanitary sewer system is to be performed before ceiling tiles are installed, no exception.
 3. After all water tests are complete, perform smoke test to ensure there are no air leaks in building. Fill all p-traps with water and temporarily cap all vents prior to testing.
 4. Procedure for Plumbing Sewer Pressurization Test Using a Visual Smoke Indicator:
 - a. Contact your local city water department, some cities may provide and supervise a smoke test for your facility.
 - b. Prior to the test, notify the local fire and police departments that you are conducting a smoke test of the facility.
 - c. Prior to the test, turn off the fire alarms. The smoke will activate the alarm. After the test is complete the building will have to be ventilated to clear smoke and then the alarm can be reactivated.
 - d. You are required to have a blower with an adjustable pressure control and liquid smoke or white smoke bombs.
 - e. Inflatable ball stops are required to block off the sewer line at the building manhole that connects to the city sewer main line.
 - f. All sewer vents on the facility have to be sealed to properly conduct the test. (Duct tape over the openings is acceptable.)
 - g. Ladders, portable lights, two-way radio communication and standard hand tools are required for access above ceilings, floor drains, etc.
 - h. A minimum of three helpers are required to conduct the test.
 - i. Prior to the test, identify rooms or problem areas that should be observed first. Plumbing drawings are required to identify the locations of vents, traps, restrooms, etc.
 - j. This test will pressurize the sewer piping (approximately 1.25" S.P.) and identify any deficiencies.
 - k. If there are questions, contact Estes, McClure & Associates, Inc.: Phone 903-581-2677.
 5. Provide TV video of all main sanitary sewers in building and to city main. Notify Owner's representative when video is to be made 48 hours prior to work.
- G. Job Photographs:
 1. Contractor is to provide digital photographs of all pipe showing sand embedment prior to covering trenches.

3.3 PLUMBING BRANCH SCHEDULES

- A. Minimum size:
 - 1. Water Closets (tank type):
 - a. 3" waste, 2" vent
 - 2. Water Closets (flush valve):
 - a. 3" waste, 2" vent
 - 3. Urinals:
 - a. 2" waste, 1-1/2" vent
 - 4. Sinks:
 - a. 2" waste, 1-1/2" vent
 - 5. Mops & Service Sinks:
 - a. 3" waste, 1-1/2" vent
 - 6. Floor Drains:
 - a. 3" waste, 1-1/2" vent
 - 7. Drinking Fountains:
 - a. 2" waste, 1-1/2" vent
 - 8. Lavatories:
 - a. 2" waste, 1-1/2" vent

END OF SECTION

SECTION 22 13 18
CONDENSATE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Condensate piping for cooling units.

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 05 30 - Pipe and Pipe Fittings - General
- C. Section 22 07 20 - Piping Insulation
- D. Section 22 13 17 - Soil, Waste, and Sanitary Drain Piping, Vent Piping, and Appurtenances
- E. Section 22 33 34 - Access Doors

1.4 REFERENCES

- A. ASTM B88 - Seamless Copper Tube for Water, Gas & Sanitation
- B. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV)

1.5 DEFINITIONS

- A. Draw-through Unit:
 - 1. A unit in which the cooling coil operates under a negative static pressure.
- B. Blow-through Unit:
 - 1. A unit in which the cooling coil operates under a positive static pressure.

1.6 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 22 00 10, General Conditions, and Division 01.
 - 2. Submit product data indicating typical catalog of information.
 - 3. Submit product data sheets indicating dimensions, general assembly, and ratings.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide condensate lines for all cooling units even if not shown on the plans.

- B. Provide a secondary condensate drain pan and secondary condensate piping for all horizontal air handlers above ceiling, even if not shown on plans.
- C. Minimum size:
 - 1. 3/4", but no smaller than the coil nipple.

2.2 PIPING

- A. Type:
 - 1. Hard drawn type DWV or type M copper
 - 2. Other type as noted on plans
 - 3. Conform to ASTM B306 or ASTM B88.

2.3 FITTINGS

- A. Type: Wrought copper joint
 - 1. Provide dielectric insulating couplings between ferrous and copper piping systems.

2.4 INSULATION

- A. All condensate lines shall be insulated per Section 22 07 20.

2.5 CONNECTIONS

- A. Type:
 - 1. Solid string hard solder
 - 2. Wire hard solder
 - 3. Cored solder will not be allowed.
- B. Material:
 - 1. Solder:
 - a. 95% tin and 5% antimony
 - 2. Flux:
 - a. Non-corrosive paste type
- C. Use a cast adapter when connecting soldered copper piping to screwed brass pipe.

2.6 ROOF PIPE SUPPORTS

- A. Manufacturers:
 - 1. MAPA MS-5
 - 2. Miro Industries Model 3 RAH (3-inch or less)
 - 3. Pipe Hangers and Devices (PHP) Model PP10
 - 4. Portable Pipe Hangers (PHP) Model PP10
 - 5. ERICO RPS 360407
- B. All roof supports to be equal to MAPA Products Model MS-5, adjustable height, select size designed for size of pipe supported. MS-5 for 4" and smaller.
 - 1. Install 1/2" rubber walk pad under each pipe support.
- C. MAPA MWP 1/2" thick rubber walk pad.
 - 1. Coordinate exact locations of supports with roofing contractor.

- D. Roof supports to support all gas piping a minimum of 6" above roof.
 - 1. Coordinate exact locations of supports with roofing contractor.
 - 2. Install 1/2" rubber walk pad under each pipe support.
- E. Spacing of Supports (Horizontal):
 - 1/2" 6 feet or less
 - 3/4" or 1" 8 feet or less
 - 1 1/4" or larger 10 feet or lessInstall supports within 2 feet of every change of direction.

2.7 ACCESSORIES

- A. Traps:
 - 1. Draw-through units:
 - a. Required on all units, unless noted otherwise on plans.
 - 2. Blow-through units:
 - a. As recommended by the unit manufacturer or as shown on the plans.
- B. Clean-outs
- C. Unions

PART 3 EXECUTION

3.1 INSTALLATION

- A. Traps:
 - 1. Install in each line serving a draw-through unit. Coordinate size and configuration with air conditioning unit manufacturer.
- B. Cleanouts:
 - 1. Install cleanouts as shown on plans.
- C. Unions:
 - 1. Install unions on both sides of the trap.
- D. Minimum Drain Line Slope:
 - 1. 1/8 inch per foot
 - 2. Insulate all condensate lines inside buildings.

END OF SECTION

SECTION 22 33 34

ACCESS DOORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Access doors

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements
- B. Section 22 05 24 - Valves - General
- C. Section 22 11 17 - Domestic Water Piping and Appurtenances
- D. Section 22 13 17 - Soil, Waste, and Sanitary Drain Piping, Vent Piping, and Appurtenances
- E. Section 22 13 18 - Condensate Piping
- F. Section 22 40 01 - Plumbing Fixtures and Fixture Carriers

1.4 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acudor
- B. Elmdor
- C. Mifab

2.2 ACCESS DOORS

- A. Locations requiring access doors:
 - 1. Concealed valves
 - 2. Traps
 - 3. Trap primers
 - 4. Controls
 - 5. Cleanouts
 - 6. Equipment above hard ceilings.
 - 7. Other equipment requiring accessibility for operation and maintenance.

- B. Type:
 - 1. Hinged flush-type steel framed door with straps and exposed narrow border.
- C. Minimum size:
 - 1. 18" x 18" unless otherwise indicated.
 - 2. 24" x 24" for equipment above hard ceilings.
 - 3. Conform to architectural panel pattern for acoustical ceilings.
 - 4. Confirm size with Building Inspector and Engineer.
- D. Construction:
 - 1. Hinges:
 - a. Concealed continuous type.
 - 2. Locking Device:
 - a. Flush cam type, screw driver operated.
- E. Fire Rating:
 - 1. Same or better fire rating than the surrounding area.
- F. Access doors located in kitchens, restrooms or areas where water is present shall be stainless steel.

2.3 FACTORY PAINTING

- A. Apply prime coat of rust inhibiting paint, unless located in wet area.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. In suspended acoustical ceilings, provide a beaded pin or other approved means for identification and easy removal where necessary.
- C. Access doors shall only be installed in areas/locations that are readily accessible.
- D. Doors shall be installed in such a manner that door will open 180 degrees.

END OF SECTION

SECTION 22 40 01

PLUMBING FIXTURES AND FIXTURE CARRIERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

- A. Water Heaters
- B. Thermometers
- C. Pressure Gages
- D. Pete's Plugs
- E. Expansion Tanks
- F. Circulating Pumps
- G. ADA Accessories
- H. Water Closets
- I. Urinals
- J. Mop sinks
- K. Lavatories
- L. Wash Fountains
- M. Electric Drinking Fountains
- N. Sinks
- O. Fixture carriers
- P. Thermostatic Mixing Valves
- Q. Back Flow Preventers
- R. Other Plumbing Fixtures and Equipment
- S. Floor Drains and Floor Sinks

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Plumbing Requirements

- B. Section 22 05 30 - Pipe and Pipe Fittings - General
- C. Section 22 11 17 - Domestic Water Piping and Appurtenances
- D. Section 22 13 17 - Soil, Waste, and Sanitary Drain Piping, Vent Piping, and Appurtenances
- E. Section 22 33 34 - Access Doors

1.4 REFERENCES

- A. ASHRAE 90-75 - American Society of Heating, Refrigerating & Air Conditioning Engineers, Inc. (Energy Conservation Standard in New Buildings)
- B. PDI WH201 - Plumbing & Drainage Institute (Water Hammer Arresters)
- C. ANSI Z21.22 - American National Standards Institute (Relief Valves & Automatic Gas Shutoff Devices)
- D. AGA - American Gas Association
- E. ADA - Americans With Disabilities Act
- F. TAS - Texas Accessibility Standards
- G. ASSE 1069 - Performance Requirements for Automatic Temperature Control Mixing Valves
- H. ASSE 1070 - Water Temperature Limiting Devices
- I. ASSE 1071 - Performance Requirements for Mixing Valves for Emergency Showers

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 22 00 10, General Conditions, and Division 01.
- B. Indicate on submittal construction materials, finishes, sizes, quantities, and related hardware.
- C. Product Data:
 - 1. Plumbing fixtures
 - 2. Carriers
 - 3. Fixture trim
- D. Certification:
 - 1. Submit certification that complete system complies with test requirements of municipality, State, and other public authorities having jurisdiction over system.
- E. Provide closeout documents as required in Division 01, Section 22 00 10.

1.6 QUALITY ASSURANCE

- A. Provide faucets, fittings, supply stops and similar devices of one manufacturer.
- B. Verify that the voltage is the same as scheduled on the electrical drawings. If not, change at no cost to the Owner.

- C. Regulatory Requirements:
 - 1. Comply with requirements in following order of precedence:
 - a. Codes, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
 - b. Provisions specified in this section.
 - c. Local Plumbing Code.

1.7 HANDLING

- A. Deliver fixtures crated and in undamaged condition.
- B. Replace damaged fixtures with new fixtures.

PART 2 PRODUCTS

2.1 GENERAL

- A. All plumbing fixtures shall be new and as shown on the plans.
- B. Furnish plumbing fixtures with carriers shown and all necessary trimming.
- C. All porcelain enameled cast iron to be acid resistant.
- D. All supplies shall be IPS brass with stops.
- E. All exposed finished metal parts shall be chromium plated.
- F. Rough bodied parts shall be heavily nickel plated.
- G. Galvanized nipples will not be permitted.
- H. Traps for lavatories, sinks, etc. shall be 17 gauge three-piece chrome plated cast brass with cleanout and IPS tailpiece and chrome plated sleeve.
- I. All escutcheons on supplies and waste shall be heavy cast brass set-screw type.
- J. Furnish faucets and supply stops with renewable seats.

2.2 WATER HEATERS

- A. Type:
 - 1. Commercial Grade Electric:
 - a. ASME Code Section IV (more than 58 KW)
 - b. Minimum Working Pressure:
 - (1) 160 psi
- B. Tank Construction:
 - 1. Insulation:
 - a. Heavy density fiberglass insulation trimmed with a baked enamel steel jacket.
 - 2. Cleanout:
 - a. Boiler type hand-hole
 - 3. Temperature and Relief Valve:
 - a. Comply with ANSI Z21.22
 - b. Discharge line from valve to be same size as valve outlet

4. Coatings:
 - a. Multiple coats of a high-temperature glass or 3166 stainless steel tank construction.
- C. Electric Tankless:
 1. Flow Switch
 2. Microprocessor Control
 3. Minimum Flow Rate: .5 GPM
 4. Element shall be replaceable cartridge insert.
- D. Approved Manufacturers:
 1. A.O. Smith
 2. Bradford White
 3. Heat Transfer Products
 4. Larrs
 5. Lochinvar
 6. Rheem
 7. State
 8. Noritz
 9. Rinnai
 10. Takagi
 11. EEMAX (Electric Tankless)
 12. Chronomite (Electric Tankless)
- E. Warranties:
 1. Commercial Grade Electric:
 - a. 3-year warranty on storage tank
 - b. 1-year warranty on parts
 2. Electric Tankless:
 - a. 1 year warranty for replaceable cartridge element.
 - b. 5 year warranty for heater body/element assembly.
- F. Provide a 4-inch thick concrete housekeeping pad and drain pan for all floor mount water heaters.

2.3 EXPANSION TANKS

- A. Approved Manufacturer:
 1. Thrush-Amtrol Model Therm-X-Trol -ASME
 2. Watts – DETA Series
 3. Bell & Gossett PTA Series
- B. Provide and install expansion tank at each water heater installation per manufacturer's requirements. All expansion tanks shall bear ASME seal that serve boilers (greater than 200,000 BTUH or 120 gallons of storage).

2.4 CIRCULATING PUMPS

- A. Approved Manufacturer:
 1. Armstrong
 2. Bell & Gossett PL Series
- B. Pumps are to be 100% bronze construction (Lead Free).
- C. Provide time clock for circulation pump control if pump is not controlled by a central building energy management system.

2.5 THERMOMETERS

- A. Type:
 - 1. 9" adjustable angle thermometer
- B. Construction:
 - 1. Temperature range:
 - a. Fahrenheit degrees as approved by the Engineer.
 - 2. Window:
 - a. Unbreakable Plexiglas.
 - b. Furnish with separable socket.
 - 3. Manufacturer/model:
 - a. Terice BX91403 ½
 - b. MILJOCO SX935

2.6 PRESSURE GAUGES

- A. Type:
 - 1. 4" dial type pressure gauge
- B. Manufacturer/model:
 - 1. Terice 500X
 - 2. MILJOCO P4509LX
 - 3. Range is minimum 1 ½ times working pressure of T & P Valve.
- C. Construction:
 - 1. Pressure range:
 - a. As approved by the Engineer.
 - 2. Cast aluminum case
 - 3. Double strength clear glass window
 - 4. Stainless steel movement
 - 5. Phosphor bronze tube
 - 6. Brass socket
 - 7. Furnish with a Terice No. 880 lever handle gauge cock.
- D. Accuracy: 1/2 of 1% of scale range.

2.7 PETE'S PLUGS

- A. Provide two sets of suitable pressure and temperature gauges for use with the plugs.

2.8 ADA ACCESSORIES

- A. P-Trap and water supplies with stop guards
 - 1. Usage: Each ADA lavatory
 - 2. Size: Verify with fixture
 - 3. Manufacturer/Model:
 - a. Truebro Lav-Guard 102 or 105 (verify usage)
 - b. Plumberex Pro Extreme #X4333 and X4114 (verify usage)

2.9 WATER CLOSETS, URINALS AND LAVATORIES

- A. Approved Manufacturers:
 - 1. American Standard
 - 2. Eljer
 - 3. Kohler

4. Sloan
5. Zurn

2.10 CARRIERS FOR WATER CLOSETS, URINALS, LAVATORIES AND ELECTRIC WATER COOLERS

- A. Water Closets
 1. Wade 300 Series
 2. Watts
 3. Mifab
 4. Zurn
 5. Josam
- B. Urinals:
 1. Wade 400 Series
 2. Watts
 3. JR Smith
 4. Mifab
 5. Zurn
 6. Josam
- C. Lavatories:
 1. Wade 520 Series
 2. Watts
 3. JR Smith
 4. Mifab
 5. Zurn
 6. Josam
- D. Electric Water Coolers:
 1. Wade 400
 2. Watts
 3. J.R. Smith
 4. Mifab
 5. Zurn
 6. Josam

2.11 WATER HYDRANTS

- A. Approved Manufacturers:
 1. Woodford
 2. Wade
 3. MAPA
 4. Mifab
 5. Josam
 6. JR Smith
 7. Zurn
 8. Prier Products
- B. All frost proof water hydrants mounted in building or roof shall be designed to not require an independent drain line, unless specifically stated on construction drawings.

2.12 FAUCETS

- A. Approved Manufacturers:
 1. American Standard

2. Chicago
3. Delta
4. Symmons
5. Moen
6. T & S Brass
7. Zurn AquaSpec
8. Speakman

2.13 SINKS

- A. Approved Manufacturers:
1. Elkay
 2. Just

2.14 ELECTRIC WATER COOLERS

- A. Approved Manufacturers:
1. Elkay
 2. Halsey-Taylor
 3. Oasis
 4. Acorn
- B. All electric water coolers shall have vandal resistant bubbler and pushbutton activation mechanism.
- C. All electric water coolers shall have mechanical control valves to provide operation and water flow in the event of loss of electrical power.

2.15 MOP SINKS

- A. Approved manufacturers:
1. Fiat
 2. Stern Williams
 3. Acorn
 4. Creative Industries Terrazzo Products, Inc.

2.16 SHOWERS

- A. Approved manufacturers:
1. Acorn
 2. Bradley

2.17 WASH FOUNTAINS

- A. Approved Manufacturers:
1. Acorn
 2. Bradley
 3. Willoughby
 4. Sloan

2.18 FLOOR DRAINS/FLOOR SINKS

- A. Approved Manufacturers:
1. J.R. Smith
 2. Josam
 3. Mifab

4. Sioux Chief
5. Wade
6. Watts
7. Zurn

2.19 FLUSH VALVES

- A. Approved Manufacturers:
 1. Automatic Sensor Type: Side Mount (with true manual override):
 - a. Sloan
 - (1) Water Closets: Sloan Royal 111 With EBV-500-A Side Mount Operator
 - (2) Urinals: Sloan Royal 186-0.5 With EBV-500-A Side Mount Operator
 - b. Zurn
 - (1) Water Closets: Zurn ZER6000AV-WS1-CPM-MOB
 - (2) Urinals: Zurn ZER6003-AV-WS1-CPM-MOB

2.20 THERMOSTATIC MIXING VALVES

- A. Approved Manufacturers:
 1. Acorn Controls
 2. Apollo
 3. Bradley
 4. Conbraco
 5. Leonard
 6. Powers
 7. Symmons
- B. Thermostatic mixing valves for showers shall comply with ASSE 1069.
- C. Thermostatic mixing valves for lavatories and sinks shall comply with ASSE 1070. Provide inlet checkstops and inlet y-strainers.
- D. Thermostatic mixing valves for emergency fixtures shall comply with ASSE 1071.

2.21 BACKFLOW PREVENTERS

- A. Reduced Pressure Zone:
 1. Bronze or FDA approved epoxy coated cast iron body.
 2. Maximum Working Pressure: 175 psi
 3. Provide full line size strainer before reduced pressure zone assembly.
 4. Provide air gap assembly.
- B. Approved Manufacturers:
 1. Apollo
 2. Conbraco
 3. Watts
 4. Zurn

PART 3 EXECUTION

3.1 PREPARATION

- A. All equipment surfaces coming in contact with walls, floors, or surfaces of other fixtures shall be ground truly flat and shall be bedded with fine dental plaster.

- B. Install an approved vacuum breaker or backflow preventer on each water supply line serving a plumbing fixture which has a water supply below the rim of the fixture. Vacuum breakers shall be designed to prevent any possible backflow through them. Where these are installed in chrome plated lines, they shall be chrome plated to match.
- C. Provide and install a check valve on the cold water supply serving each and every water heater on project.
- D. Temperature and pressure relief line to be piped full sized and in copper to exterior of building, or as noted on plans.
- E. Set water heater storage temperature to 140°F.

3.2 INSTALLATION

- A. Furnish and completely install all fixtures shown on plans and as specified.
- B. Properly anchor all fixtures, lines, or equipment to construction.
- C. Clean all plumbing fixtures before final inspection and acceptance by the Architect.
- D. Install all fixtures to proper heights as shown on the plans and in the codes. Refer to Texas Accessibility Standards. Coordinate height with plans. If different from engineering plans, contact the Architect for the correct height. Do not install until written approval is issued by the Architect. If fixture cannot be installed to proper height given, contact Architect for direction. No cost changes will be allowed for changes to piping to correct the problem.
- E. Install Handi Lav-Guard Kits per manufacturer on ADA lavatories.
- F. Provide and install thermostatic mixing valves at all ADA lavatories, sinks, wash stations and lavatory systems.
- G. Install water heater expansion tank on cold water entering the water heater or storage tank.
- H. Horizontal Y-Strainers shall be located:
 - 1. On domestic water main entry into the building provide a horizontal Y-strainer downstream of the building isolation valve and upstream of the backflow preventer.
 - 2. Where infrared controlled lavatories or hand sinks are provided downstream of the supply stops exposed under the fixture.
 - 3. In gang or private (individual) restrooms directly downstream of the isolation valves behind the access panel.

3.3 FIELD QUALITY CONTROL

- A. Inspect all faucets, flush valves, stop valves and other equipment for proper amount of water discharged. Adjust as required to meet low water consumption and ADA/Texas Accessibility Standards.
- B. Correct any faucet or other equipment as directed by the Architect/Engineer.
- C. Protect all drains during construction. Install covers on all floor drains and floor sinks until substantial completion.
- D. Do not install mop sinks until substantial completion.

END OF SECTION

SECTION 22 66 54

CHEMICAL WASTE AND VENT PIPING SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 22 00 10, apply to this Section.

1.2 SCOPE

- A. Chemical and plenum rated piping and vents for drains and sinks upstream of the dilution basin and where specifically noted on the drawings.

1.3 RELATED SECTIONS

- A. Section 22 00 10 - Basic Mechanical Requirements
- B. Section 22 05 30 - Pipe and Pipe Fittings - General
- C. Section 22 13 17 - Soil, Waste and Sanitary Drain Piping, Vent Piping and Appurtenances
- D. Section 22 33 34 - Access Doors
- E. Section 22 40 01 - Plumbing Fixtures and Fixture Carriers

1.4 REFERENCES

ASTM D635-98	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D101-02b	Standard Specification for Polypropylene Injection and Extrusion Materials
ASTM D1784	Standard Specification for Rigid PVC and CPVC Compounds
ASTM F1412	Standard Specification for Polyolefin Pipe & Fittings for Corrosive Waste Drainage Systems
ASTM F1673-04	Standard Specification for Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials.
ASTM F441	Standard Specification for CPVC Plastic Pipe, Schedules 40 and 80
ASTM D3311	Standard Specification for Drain, Waste and Vent (DWV) Plastic Fitting Patterns
ASTM F2618	Standard Specification for CPVC Pipe and Fittings for Chemical Waste Drainage Systems
ASTM F493	Specification for Solvent Cements for CPVC Plastic Pipe and Fittings

1.5 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.
- B. Submit product data sheets with methods of making joints.
- C. Submit qualifications of installer of particular product.

PART 2 PRODUCTS

2.1 GENERAL

- A. System to include pipe, fittings, traps and recommended adapters to connect other piping material where applicable.

2.2 PIPING AND FITTINGS

- A. Type: Acid Resistant
- B. Material:
 - 1. Flame retardant polypropylene (PP) meets requirements of ASTM F1412.
- C. Maximum Average Burn Time:
 - 1. Pipe: 0 seconds
 - 2. Fittings: 80 seconds
- D. Maximum Extent of Burning:
 - 1. Pipe: 13 mm
 - 2. Fittings: 20 mm
- E. Wall Thickness:
 - 1. Schedule 40 wall thickness
- F. Manufacturers:
 - 1. Enfield Industrial Corp.
 - 2. Fuseal
 - 3. George Fischer
 - 4. Orion
 - 5. Zurn

2.3 JOINTS

- A. Connections Above Slab (That Are Accessible):
 - 1. Manufacturer/Model:
 - a. Enfield Mechanical Joint
 - b. Fuseal Mechanical Joint
 - c. Orion Mechanical Joint
 - d. Zurn Mechanical Joint
 - 2. Connections containing metal components are prohibited.
- B. Connections Below Slab (Or Connections Above Slab That Are Not Accessible):
 - 1. Manufacturer/Model:
 - a. Enfield Enfusion Joint
 - b. Fuseal II Fusion
 - c. Orion Rionfuse
 - d. Zurn Fusion Lock
- C. Connections Between PVDF and Other Types of Piping Material:
 - 1. Manufacturer/Model:
 - a. Pipe Manufacturer Adapters

2.4 CHLORINATED POLY VINYL CHLORIDE (CPVC)

- A. Material
 - 1. Chlorinated Poly Vinyl Chloride (CPVC), Conform to ASTM F 2618.
- B. Wall Thickness:
 - 1. Schedule 40 Wall Thickness
- C. Manufacturers:
 - 1. Charlotte Pipe & Foundry
 - 2. Spears Manufacturing
 - 3. George Fischer
- D. Joints:
 - 1. Connections Above and Below Slab:
 - a. Solvent cement welding. Comply with ASTM F493.
 - 2. Connections between other types of piping material.
 - a. Manufacturer/Model:
 - (1) Pipe Manufacturers Adapters

2.5 SYSTEMS COMPATIBILITY

- A. All pipe, fittings, and electro fusion equipment shall be from the same manufacturer.

2.6 NEUTRALIZATION BASINS

- A. Material:
 - 1. Polypropylene
- B. Provide as shown on drawings.
- C. Fill with limestone chips per manufacturer's recommendation.
- D. Install per construction document details.
- E. Provide and install cleanouts on both side of tank.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with contract drawings, manufacturer's recommendations and the local plumbing code.
- B. Install entire system free of stress and in proper alignment without strain.
- C. Supply necessary extension to install dilution basin at final grade level.
- D. Install vents in accordance with these specifications.
- E. Install hangers a minimum of 4 feet on center.
- F. Provide PVDF piping in all return air plenums.

- G. The manufacturer's certified installation trainer shall be on site for initial job start up and must train and certify all installers per the manufacturer's installation procedures. Each installer must pass a written exam, make a test joint and be issued a certification card that must be available for review at all times. Installers shall follow all manufacturers' recommendations regarding installation of their systems.

3.2 TESTING

- A. Test the system in the same manner as the sanitary drain piping (see Section 22 13 17).
- B. Perform any further tests required by the local plumbing inspector.

END OF SECTION

SECTION 23 00 00

BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, and Division 01 Specifications apply to this Section.

1.2 SECTION INCLUDES

- A. Basic mechanical requirements necessary to provide complete installation of all Division 23 work.

1.3 WORK INCLUDED

- A. This section of work comprises furnishing of all materials, equipment, tools, scaffolding, rigging, hoisting, labor and transportation necessary for the complete installation of the mechanical systems as shown on the plans and as specified herein.
- B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Architectural, Structural, Plumbing, Heating, Ventilating, Air Conditioning and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.

1.4 CODES & REFERENCE STANDARDS

- A. General:
 - 1. Perform all Division 23 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.
 - 2. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes.
 - 3. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.
 - 4. The date of the code or standard that is in effect on the date of issue of the contract documents except when a particular publication date is specified.
 - 5. The Contractor shall be held responsible for verifying all local codes and ordinances that may alter any part of the plans or specifications. The Contractor shall bear all costs for correcting the deficiencies.
 - 6. Where local codes and ordinances are not in writing or on record but a local precedence has been set, the Owner shall pay for any additional cost incurred.
- B. Applicable Codes and Standards for All Division 23 Work:
 - 1. International Building Code

2. International Gas Code
3. International Plumbing Code
4. International Mechanical Code
5. International Energy Conservation Code
6. National Electrical Code
7. American Society of Heating, Refrigerating and Air Conditioning Engineers Standards.
8. Occupational Safety and Health Administration Standards:
 - a. OSHA Standard 2207 - Construction Industry Standards
 - b. OSHA 29 CFR Part 1926 – Regulation of Excavation
 - c. Texas Underground Facility Damage Prevention Act (H.B. 2295)
 - d. All other applicable standards
9. National Fire Protection Association:
 - a. NFPA No. 90A Installation of Air Conditioning and Ventilating Systems
10. Texas State Board of Insurance Standards
11. Clean Air Act and Clean Air Act Amendments
12. State Codes:
 - a. Texas Department of Labor Boiler Rules and Regulations
 - b. All other applicable codes
13. Local Municipal Codes and Ordinances

1.5 SCHEDULE OF ABBREVIATIONS

- A. Reference Standards are listed in Section 23 using abbreviations listed below:
- | | |
|--------|---|
| AABC | Associated Air Balance Council |
| AASHTO | American Association of State Highway and Transportation Officials |
| ADA | Americans with Disabilities Act |
| ADC | Air Diffusion Council |
| A/E | Architect/ Engineer |
| AGA | American Gas Association |
| AMCA | Air Moving and Conditioning Association |
| ANSI | American National Standards Institute |
| AHRI | Air-Conditioning and Refrigeration Institute |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASPE | American Society of Plumbing Engineers |
| ASTM | American Society for Testing and Materials |
| AWE | American Welding Society |
| AWWA | American Water Works Association |
| CGA | Compressed Gas Association |
| CISPI | Cast Iron Soil Pipe Institute |
| CS | Commercial Standard |
| CSA | Canadian Standards Association |
| DIPRA | Ductile Iron Pipe Research Association |
| DOT | Department of Transportation |
| DOC | Department of Commerce |
| FCC | Federal Communications Commission |
| FM | Factory Mutual |
| FS | Federal Specification |
| GSHPA | Ground Source Heat Pump Association |
| IBC | International Building Code |
| ITL | Independent Testing Laboratories |
| NEC | National Electric Code |
| NFPA | National Fire Protection Association |
| NSF | National Sanitation Foundation |
| OSHA | Occupational Safety and Health Administration |
| PDI | Plumbing and Drainage Institute |

SMACNA	Sheet Metal and Air Conditioning National Association
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health
TWC	Texas Water Commission
UBC	Uniform Building Code
UL	Underwriters Laboratories

1.6 QUALITY ASSURANCE

- A. Provide complete installations of all systems.
- B. Furnish all items of equipment, material, and labor to complete the Contract even though each and every item necessary is not specifically mentioned or shown.
- C. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern.
- D. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.
- E. All mechanical equipment and fixtures shall be the same brand unless scheduled differently on plans.
- F. Contractor's Responsibility:
 - 1. Erect barricades, protective fencing, and signs to prevent injury to personnel on site.
 - 2. Make permanent connection to utilities or existing lines. Determine depth and location, and bid accordingly.
 - 3. Relocate and repair any existing lines cut by general construction work.
 - 4. Pay all costs in connection with metering devices.
 - 5. Plans do not show exact location and elevations of lines, nor do they show all offsets required.
 - 6. Deviate from plans as required to conform to the general construction and provide proper grading.
 - 7. Maintain all utility services during construction to existing portions of job that remain.
 - 8. Procure and pay for all necessary permits or licenses to carry out the work.
 - 9. Obtain and pay for all the necessary certificates of approval which must be delivered to the A/E before final acceptance of the work.
 - 10. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.
 - 11. Protect work from damage by other trades.
 - 12. Make all tests required by law; pay all costs in connection with the testing.
 - 13. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.
 - 14. Provide motor starters, controls, relays, all low-voltage wiring, conduit and wiring related to HVAC and other equipment and devices to form a complete working system. See Section 26 00 00.

1.7 DEFINITIONS

- A. Approval:
 - 1. It is understood that approval must be obtained from the A/E in writing before proceeding with the proposed work.
 - 2. Approval by the A/E of any changes, submitted by the Contractor will be considered as general only to aid the Contractor in expediting his work.

- B. Contractor:
 - 1. The Contractor engaged to execute the work included in a particular section only, even though he may be technically described as a Subcontractor to the General Contractor.
 - 2. If the Contractor engaged to execute said work employs Sub-Contractors to perform various portions of the work included under this Section, he shall be held responsible for the execution of same, in full conformity with Contract Document requirements.
 - 3. The Contractor shall cooperate at all times and shall be responsible for the satisfactory cooperation of his Subcontractors with the other Contractors on the job so that all of the various phases of the work may be properly coordinated without unnecessary delays or damage to any parts of the work of any Contractor.
- C. Provide:
 - 1. Defined as requiring the furnishing and installing of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

1.8 WARRANTY

- A. The Contractor shall warranty his work against defective materials and workmanship for a period of one year from date of acceptance of the job.
- B. Neither the final payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.
- C. He shall remedy any defects due thereto, and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from date of substantial completion.
- D. The Owner shall give notice of observed defects with reasonable promptness.
- E. This Guarantee shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.9 SITE VISIT

- A. Before submitting his proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required.
- B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.10 SUBMITTALS

- A. Refer to Section 23 00 90 for submittal procedures.

1.11 PROJECT RECORD DOCUMENTS

- A. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building.

- B. Upon submitting his request for final payment, he shall turn over to the A/E, for subsequent transmittal to the Owner, a clean, neatly marked set of reproducible plans showing "as installed" work and an electronic file with changes of materials.
- C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication (2 each), prepared in 3 ring binders of sufficient size, black in color, neat in appearance, and turned over to the A/E for checking and subsequent delivery to the Owner. Electronic copies of the following are also acceptable, but they must be saved to a single flash drive or external hard drive:
 - 1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
 - 2. Approved fixture brochures.
 - 3. Copies of approved shop drawings.
 - 4. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
 - 5. Any and all other data and/or plans required during construction.
 - 6. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.
- D. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
 - 1. General Contractor and all sub-contractors.
 - 2. Major Equipment Suppliers.

1.12 TRAINING

- A. Upon completion of the work and at a time designated by the Owner's representative, provide a formal training session for the Owner's operating personnel to include location, operation, and maintenance of all mechanical equipment and systems, some sections have further instructions.
- B. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Owner's representative.
- C. At the conclusion of the instruction, obtain the signatures of the attendees on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Owner's representative and Engineer as a condition of final acceptance.

1.13 PLANS AND SPECIFICATIONS

- A. The plans show diagrammatically the locations of the various lines, ducts, conduits, fixtures, and equipment and the method of connecting and controlling them.
- B. It is not intended to show every connection in detail and all fittings required for a complete system.
- C. The systems shall include but are not limited to the items shown on the plans.
- D. Exact locations of these items shall be determined by reference to the general plans and measurements of the building and in cooperation with other contractors, and in all cases, shall be subject to the approval of the A/E.
- E. The A/E reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.

- F. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.14 UTILITIES, LOCATIONS, AND ELEVATIONS

- A. Locations and elevations of the various utilities within the scope of this work have been obtained from the City and/or other substantially reliable sources and are offered separately from the Contract documents, as a general guide only, without guarantees as to accuracy.
- B. The Contractor shall examine the site, shall verify to his own satisfaction the locations, elevations and availability of all utilities and services required, and shall adequately inform himself as to their relation to the work; the submission of bids shall be deemed evidence thereof.
- C. The Contractor shall coordinate all services with the Utility Companies during construction, coordinate changes made by Utility Companies to the design of project, and coordinate with the Owner, A/E, and Utility the scheduling of any shutdowns or delays that may occur in providing service.
- D. The Contractor shall verify location, conduct all necessary tests, inspections, coordinate with Owner's representatives and utilities, and check for existing underground utilities and lines before ditching.
- E. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.

1.15 SUBSTITUTION OF PRODUCTS

- A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.
- B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.
- C. The Engineer will consider all such submittals and the A/E will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.
- D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.
- E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.
- F. Requests for substitution are understood to mean that the Contractor:
 - 1. Has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - 2. Will provide the same guarantee for the substitution that he would for that specified.
 - 3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.

4. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances:
 - a. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
 - b. The specified product is unavailable through no fault of the Contractor.
 - c. The manufacturer refuses to warranty the specified products as required.
 - d. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
 - e. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.
5. Revisions to the mechanical system shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.16 PROTECTION OF EQUIPMENT AND MATERIALS

- A. The Contractor shall take such precautions as may be necessary to properly protect his apparatus from damage.
- B. This shall include the creation of all required temporary shelters to adequately protect any apparatus above the floor of the construction and the covering of apparatus in the completed building with tarpaulins or other protective covering.
- C. Failure to comply with the above to the satisfaction of the Owner's inspector will be sufficient cause for the rejection of the equipment in question and its complete replacement by this Contractor.
- D. All apparatus shall be cribbed up from the floor or ground by the Contractor and covered with tarpaulins or other protective covering where necessary or directed.

1.17 FINAL INSPECTION

- A. It shall be the duty of this Contractor to make a careful inspection trip of the entire project, assuring himself that the work on the project is ready for final acceptance before calling upon the A/E to make a final inspection.
- B. To avoid delay of final acceptance of the work, the Contractor shall have all necessary bonds, warranties, receipts, affidavits, etc., called for in the various articles of these specifications, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and shall deliver the same to the A/E at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc., before preparing for submission to verify that the terms check with the requirements of the specifications.

1.18 ASBESTOS

- A. No asbestos or asbestos containing materials shall be permitted in this project.

1.19 CUTTING AND PATCHING

- A. All Subcontractors shall notify the General Contractor sufficiently ahead of construction of any floors, walls, ceiling, roof, etc., of any openings that will be required for his work.
- B. He shall see that all sleeves required for his work are set at proper times so as to avoid delay of the job.

- C. All necessary cutting of walls, floors, partitions, ceilings, etc., as required for the proper installation of the work under this Contract shall be done at the Subcontractor's expense in a neat and workmanlike manner, and as approved by the A/E.
- D. No joists, beams, girders or columns shall be cut by any Contractor without first obtaining written permission of the A/E.
- E. Patching of openings and/or alterations shall be provided by the General Contractor.
- F. All openings in firewalls and floors shall be completely sealed after installation for a completely airtight installation. Sealing material shall be non-combustible and UL approved. The installed sealing assembly shall not cause the fire rating of the penetrated structure to be decreased.
- G. All openings in exterior walls shall be sealed watertight.

1.20 IDENTIFICATION

- A. Refer to Section 23 05 53.

1.21 MANUFACTURER'S INSTRUCTIONS

- A. All equipment and devices shall be installed in accordance with these plans and specifications, manufacturer's instructions and applicable codes.
- B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions.
- C. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.22 RELATED WORK

- A. Whether specifically identified or not, it is the responsibility of the Mechanical Contractor to coordinate all mechanical work with all related trades.

1.23 ELECTRICAL WIRING AND EQUIPMENT FOR MECHANICAL SYSTEMS

- A. All wiring, conduit, boxes, equipment (controls, thermostats, relays, contactors, motor starters, heaters, switches) and any other control devices or equipment required to form a complete and properly operating system, shall be the responsibility of the Mechanical Contractor.
- B. The Electrical Contractor shall only provide line voltage (including hook-up) to all mechanical equipment.
- C. All mechanical controls and devices shall be low voltage unless otherwise noted or shown on the plans. Where line voltage controls or devices are noted, the Contractor shall provide complete wiring diagrams (approved by the Engineer) to the Electrical Contractor prior to final hook-up.
- D. All electrical resistance heating elements which are scheduled to be served by three-phase electrical power shall impose an equal electrical load on all phases. Electrical resistance elements which are not balanced over all three phases are not acceptable.

- E. The Mechanical and Electrical plans are based on the equipment and devices scheduled as shown on the plans or as called for in the specifications. Should any mechanical equipment or device be changed or approved from those which are shown or noted, all electrical and/or mechanical changes shall be made at the expense of the trade or contractor initiating the change with no expense to the Owner, Architect, Engineer or their representatives.
- F. All wiring provided by this Contractor shall be installed in a workmanlike manner using tie wraps, labels, anchors and etc. Loose wiring is not acceptable.
- G. All conduit and boxes required in all walls for control purposes (thermostats, etc.) shall be provided by electrical contractor. All conduit required in attic, clear spaces, or on roof shall be by mechanical contractor.

1.24 DEMOLITION AND REMODEL

- A. It shall be the responsibility of this Contractor to see that all demolition and remodeling work involving his trade (including but not limited to, condensate lines, air handlers, mechanical equipment, etc.) is accomplished in a manner and completeness to provide the appearance of new construction work.

1.25 OPERATION PRIOR TO COMPLETION

- A. When any piece of mechanical or electrical equipment is operable and the Contractor needs to operate the equipment, he may do so providing that he properly supervises the operation.
- B. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner.
- C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all punch list items before final acceptance by the Owner.
- D. The date of acceptance and the start of the warranty may not be the same date.

1.26 SAFETY GUARDS

- A. Contractor shall furnish and install all safety guards required. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

1.27 FLAME SPREAD PROPERTIES OF MATERIALS

- A. All materials and adhesives used for air conditioning filters, acoustical lining and insulation shall conform to NFPA and UL life and flame spread properties of materials.
- B. The composite classifications shall not exceed the flame spread rating and the smoke development rating as outlined by NFPA 255/ ASTM E-84 for the basic material, the finishes, adhesives, etc., specified for each system, and shall be such when completely assembled.

1.28 FILTER ASSEMBLIES

- A. All filter housings and assemblies shall be factory built and supplied with the unit. A separate filter rack may be required and is the responsibility of the mechanical contractor to provide.
- B. Access doors (panels) which must be opened to change the air filters shall be labeled "Filter Access" and the number and size of required filters shall be identified.

- C. No piping conduit etc. shall be installed in front of this access door.
- D. Install clean filters prior to substantial completion.
- E. All air handlers shall have filters installed upstream of all coils.

1.29 LEAD MATERIALS

- A. No lead or lead containing materials shall be allowed in any domestic or potable water supply piping, valves, fixtures, components, equipment or any other item.

1.30 REFRIGERANTS

- A. Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) shall not be allowed in any equipment on this project.
- B. Comply with ASHRAE Standards 15 and 34.

1.31 REFRIGERANT RECOVERY AND RECYCLE

- A. Refrigerants shall not be released to the environment.
- B. Contractor shall provide recovery and recycle equipment that has been certified by the Electrical Testing Laboratories or Underwriters Laboratories.
- C. Contractor shall also provide properly trained and certified (in accordance with EPA) personnel for refrigerant work during installation, demolition, start-up, servicing, etc.

1.32 ACCESS CLEARANCE

- A. Proper access to all installed equipment shall be provided. The Mechanical Contractor shall label all points of access immediately upon installation with a marker pen.
- B. A minimum of 3 feet shall be maintained in front of all access points.
- C. If another trade violates this space, the Mechanical Contractor shall immediately notify the General Contractor to correct this condition.
- D. When equipment is installed above lay-in ceiling the Mechanical Contractor shall coordinate with the Ceiling Contractor to provide access without removing part of T-bar ceiling.
- E. No speakers, lights, fire alarm equipment, etc. shall be installed in lay-in ceiling tiles where access is to be gained.

PART 2 PRODUCTS

- A. Not Applicable

PART 3 EXECUTION

3.1 TESTING

- A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation regardless of the season the contractor shall test all HVAC equipment in both heating and cooling modes.
- B. Each and every phase of the new air conditioning, heating and ventilating systems shall be operated separately, or in conjunction with the other, for a period of time, to demonstrate to the satisfaction of the A/E the ability of the equipment to meet the capacity and performance requirements while maintaining design conditions in accordance with the true intent and purpose of these specifications.
- C. Previous to such performance tests, the Contractor shall have set all valves, dampers, motors, controllers, thermostats, etc., and shall have the system operating and maintaining design temperatures, humidity and air circulation throughout all areas of the building.
- D. Make adjustments as required to ensure proper functioning of all systems.
- E. Special tests on individual systems are specified under individual sections.
- F. See Section 23 05 93 for Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 23 00 90

HVAC SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This section supplements Division 01 Submittal Procedures and contains additional requirements applicable to Division 23 submittals.

1.2 SECTION INCLUDES

- A. This section includes, but is not limited to:
 - 1. HVAC submittal procedures
 - 2. List of required Division 23 submittals to the engineer
 - 3. This section applies only to the Division 23 specifications. Submittals required by other specification divisions are not included here, even though the same subcontractor may be providing work under other divisions.

1.3 RELATED SECTION

- A. Division 01 – Submittal Procedures

1.4 DEFINITIONS

- A. Product Data: Illustrations, standard schedules, performance charts, instructions, and brochures furnished by the contractor, subcontractor, manufacturer, or supplier to illustrate materials or equipment or to illustrate some portion of the work. Provide a summary of scheduled items with all data in schedules.
- B. Shop Drawings: Drawings, diagrams, schedules and other data specifically prepared for the work by the contractor, subcontractor, manufacturer, or supplier to illustrate some portion of the work.
- C. Equipment/Material Submittal Package: A compilation of the product data, shop drawings, and other items as required by the specifications, submitted near the start of the work. Typically, the specifications require the initial submittal package to be submitted within a certain number of days after the work starts.
- D. Quality Assurance Submittal: Items submitted before and during the execution of a particular portion of the work for the purpose of guarding against defects and deficiencies.
- E. Quality Control Submittal: Items submitted at the completion of a particular portion of the work for the purpose of evaluating completed activities and elements of the work for conformance with contract requirements (e.g. start-up reports).
- F. Closeout Submittals: Items submitted at or near the completion of the contract.

1.5 SUBMITTALS

- A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the architect, engineer and owner.

- B. Manufacturers: Manufacturers submitted shall be as per the acceptable manufacturers listed in each specification section or referenced schedule. For additional manufacturers requiring approval, reference the Substitution of Products article in Section 23 00 00.
- C. Required Submittals: Refer to the Submittals article of each individual Division 23 specification section for the required items to be submitted.
- D. Contractor's Coordination Submittals: The contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the project, but such data shall remain between the contractor and his subcontractors and will not be reviewed by the engineer.
- E. Electronic Submittals: E-mail or other electronic forms of submittals from the contractor are required. The procedures described in this section shall be as follows:
 - 1. The contractor shall supply one electronic copy of the submittal.
 - 2. The electronic files will either be e-mailed to the architect, or posted to a project management and information exchange web site, depending on the architect's requirements. The architect and contractor can distribute copies of the files as desired.
 - 3. The engineer will retain an electronic copy of the submittal and all responses.
- F. Coordination Correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the initial submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the initial submittal package along with a copy of the correspondence.
- G. Unapproved Products: If materials or equipment are installed before being reviewed by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of rejected materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.
- H. Product Data: Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink or highlighting. Data of a general nature shall not be acceptable.
- I. Shop Drawings:
 - 1. Scale and measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item.
 - 2. Electronic shop drawing submittals are required.

PART 2 PRODUCTS

- A. Not applicable

PART 3 EXECUTION

3.1 SUBMITTALS

- A. Make submittals of product data, shop drawings, samples, quality assurance submittals, quality control submittals, and other items in accordance with the requirements of this section, applicable sections in Division 23, and additional requirements of each individual Division 23 specification section.
- B. Grouping of Submittals:
 - 1. The submittal package shall be coordinated and included in a single submission. Multiple submissions are not acceptable except where prior written approval has been obtained from the engineer. Partial submittals may be rejected, without being reviewed, as not complying with the provisions of the contract.
 - 2. In the case that multiple submissions are approved, it is the responsibility of the contractor to maintain and update a submittal check list. The contractor shall ensure that all applicable submittal sections are submitted to the Engineer. If a submittal section is not submitted, it will be considered rejected until reviewed by the Engineer.
 - 3. If submittal sections are submitted as individual submittal files, the submittal sections will be grouped and returned as one file with one set of submittal responses.
- C. Electronic Submittal Organization:
 - 1. Electronic submittals are to be submitted as a single PDF file. Within the PDF file, each section shall be bookmarked.
 - 2. Provide an electronic submittal cover sheet that lists at least the following:
 - a. Project name
 - b. Date
 - c. Name and address of architect
 - d. Name and address of engineer
 - e. Name, address and telephone number of prime contractor
 - f. Name, address and telephone number of HVAC contractor
 - g. Name, address and telephone number of HVAC supplier
 - 3. Provide an electronic index sheet listing all items submitted.
 - 4. The contractor shall call to the attention of the engineer, clouded in the submittal and noted after the index sheet, any instance in which the submittals are known to differ from the requirements of the contract documents.
 - 5. Organize all required items by specification section. The material for each specification section shall be organized as follows:
 - a. Provide an electronic section cover sheet that lists the same information as the submittal cover sheet, plus the specification number and title and the name, address and telephone number of the vendor or vendor's representative, if applicable.
 - b. Refer to the individual Division 23 specification sections for any required organization of the submittal material within each submittal section.
 - c. Bookmarked sections shall be arranged by specification section number in numerical order.
 - d. Submit in accordance with these procedures and procedures described in Division 01 Submittal Procedures.
 - e. Submittals not organized as described here may be rejected, without being reviewed, as not complying with the provisions of the contract.
- D. Response to engineer's review:
 - 1. Review comments: Review comments of the engineer will either be shown on the returned sets to the contractor, or shown on a document attached to the sets. If the comments are on an attached document, then the engineer will place a note on the submittal referring to the attached comments. In such cases, the engineer's signature will appear only on the attached document. If the attached, signed document becomes physically separated from the submittal, then the submittal will no longer be considered as being a reviewed submittal.

2. Complete rejection: If the submittal is not complete or does not meet the requirements of this specification section, then the engineer may reject the entire submittal and return the submittal without further review or comment. In such cases, the entire submittal shall be completely revised and resubmitted. The resubmittal shall be given a new submittal number and shall be documented and processed as a separate submittal from the original.
 3. Held for completion: If the submittal is not complete, but is only missing some minor item, the engineer may, at the engineer's sole discretion, hold the submittal rather than rejecting and returning the submittal. In such cases, the engineer will notify the architect and contractor that the submittal is being held for completion. The contractor will be given a predetermined amount of time to provide the missing item. Upon receipt of the missing item, the engineer will insert the missing item into the submittal package and proceed with the review process.
 4. Partial rejection: The engineer may reject only certain portions of the submittal. In such cases, only those rejected portions or items need to be revised and resubmitted.
 5. Provide as noted and corrected: The engineer may note a required change to a submitted item, but may not consider the change serious enough to require a resubmittal. In such cases, the engineer will note that the item is to be provided as noted or corrected. In such cases, the contractor may proceed to provide the item. However, if subsequent observations reveal that the noted change was not made, then the contractor shall be liable for removal and replacement of the item at no additional cost to the owner.
 6. Reviewed without comment: The contractor may proceed to provide all materials and equipment as submitted.
- E. Close-out Submittals:
1. Provide close-out submittals in accordance with the requirements of Division 1.

Section	Submit on the following	1	2	3	4	Arch Sub #
23 05 53	Identification for HVAC Piping and Equipment					
	Label material and attachment method (No adhesives)					
	Sample identification tag(s)					
23 05 93	Testing, Adjusting, and Balancing for HVAC					
	Test and Balance Company					
	Sample test and balance forms					
23 07 13	Duct and Grille Insulation					
	Insulation thickness and R-value					
23 07 21	Refrigerant Piping Insulation					
23 23 00	Refrigerant Piping					
	Piping material					
23 31 13	Metal Ductwork					
	Ductwork material					
	Type of ductwork					
23 33 33	Access Doors					
	Access door material					
23 34 16	HVAC Fans					
	Fan manufacturer					
	Voltage/ phase					
	Fan CFM					
	Fan static pressure					
23 37 13	Diffusers, Registers, and Grilles					
	Grille manufacturer					
23 81 26	Split System HVAC Units					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					
	Unit options and specifics					
23 81 27	Small Capacity Split System Units					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					
1 - Reviewed 2 - Furnish as corrected in comments, resubmit not required 3 - Revise and Resubmit based on comments 4 - Rejected based on comments						

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Isolation pads
- B. Concrete bases
- C. Expansion joints
- D. Other supports

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 09 13 – Programmable Control Devices for HVAC
- C. Section 23 31 13 – Metal Ductwork
- D. Section 23 34 16 – HVAC Fans
- E. Section 23 81 26 – Split System HVAC Units

1.4 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all items specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
 - 2. Submit shop drawings and catalog data with locations of use.

1.5 REFERENCES

- A. Refer to Section 23 00 00 for complete names of references identified in this section.
- B. SMACNA Standards
- C. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers

1.6 QUALITY ASSURANCE

- A. Isolation devices must be provided by a company whose sole business is to provide isolation equipment.
- B. All equipment and materials to be installed in workmanlike manner by experienced mechanics and as recommended by the manufacturers.

- C. Design Data: Complete design of isolation equipment including confirmation that no noise will be transmitted to structure of building.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide isolation and support devices as required for all mechanical equipment.

2.2 MANUFACTURERS

- A. Amber/Booth
- B. Anvil
- C. Kenetics
- D. Korfund Vibration Mountings
- E. Mason
- F. Peabody
- G. Vibro Acoustics

2.3 CONDENSING UNIT ISOLATION

- A. Provide isolation pad between unit and structure as shown on plans.

2.4 FLEXIBLE DUCT CONNECTIONS

- A. Use "Ventglas" fabric, fireproof, waterproof, and mildew resistant, approximately 30 ounces per square yard.
- B. Comply with SMACNA standards.

2.5 HVAC PIPE SUPPORTS

- A. Hangers:
 - 1. All Copper Piping
 - a. Copper plated ferrous hangers.
 - 2. 2" and smaller piping in walls:
 - a. May be split cast ring type with fastening device in walls and chases.
 - 3. All Other Above Ceiling Locations:
 - a. Adjustable clevis type. Hangers to accommodate circumference of pipe and saddles.
- B. Hanger Rods:
 - 1. Type:
 - a. Minimum 3/8 inch diameter with machine threads.
- C. Minimum Steel Hanger Rod Diameter for Individually Suspended Horizontal Pipes:
 - 1. 2" and smaller diameter pipe:
 - a. 3/8"

2. 2-1/2" to 3-1/2" diameter pipe:
 - a. 1/2"
3. 4" to 5" diameter pipe:
 - a. 5/8"
4. 6" diameter pipe or larger:
 - a. 3/4"

2.6 SLEEVES

- A. Application:
 1. Provide sleeves for all pipes and conduits which pass through a concrete slab, masonry wall/concrete wall, roof or other portion of the building structure.
- B. Above Grade and/or dry locations:
 1. Material:
 - a. 20 or 22 gauge galvanized steel.
 2. Size:
 - a. As necessary to allow free passage of the insulated pipe.
- C. Passing through fire-rated enclosures:
 1. Material:
 - a. Galvanized or black steel pipe.
 - b. Non-combustible.
 - c. PVC will not be allowed.

PART 3 - EXECUTION

3.1 ISOLATION DEVICES AND PAD INSTALLATION

- A. Install isolation pads between floor and equipment pads according to manufacturer's recommendations and approved shop drawings.
- B. Install flexible duct connections where ducts connect to fans or air handling units.
- C. All joints to be airtight.
- D. Provide a minimum of 1/2" slack in connections, and a minimum of 2½" distance between the edges of ducts.
- E. Comply with recommendations of ASHRAE for the selection and application of vibration materials and units.

3.2 SECURING AND SUPPORTING OF HVAC PIPING

- A. Support all pipe from the building structure by means of approved hangers and supports while maintaining required grade and pitch, preventing vibration and providing for expansion and contraction.
- B. Secure all hangers to approved inserts wherever possible.
- C. Set hanger inserts in place when the concrete is poured.
- D. If Joists Are Used for Attachment:
 1. 2" diameter or smaller:
 - a. May be attached to the bottom of joists.

2. Greater than 2" diameter:
 - a. Must be attached to the top cord of the joists.
 3. Do not support any piping and trapeze hangers from joist bridging on roof and floor deck.
- E. If Structural Steel Framing Is Used for Attachment:
1. Use approved beam clamps.
 2. Where required, install channels to span between framing members.
 3. Do not attach hangers to the roof deck or cross bracing.
- F. Hanger Spacing:
1. Schedule 40 Black Steel Piping (Chilled water/ Hot water piping):
 - a. 1/2" diameter pipe → 6'-0" or less
 - b. 3/4" diameter pipe → 8'-0" or less
 - c. 1-1/4" diameter pipe → 10'-0" or less
 - d. Vertical:
 - (1) Every Floor Level Minimum
 - (2) Adequately support at their bases, either by a suitable hanger placed in the horizontal line near the riser, or by a base fitting set on a pedestal or foundation.
 - (3) Support from each floor slab by means of an approved clamp-type support which bears on the slab or beam.
 2. Copper Piping (Refrigerant Piping):
 - a. Smaller Than 1 1/4" → 6'-0" or less
 - b. 1 1/2" and Larger → 10'-0" or less
 - c. Vertical → 10'-0" or less
- G. Change of Direction:
1. Install supports within two feet of change of direction.
 2. Brackets of approved type may be used along the walls.
 3. Install hangers within 2 feet of each change in vertical or horizontal direction, pipe tees and on each side of valves, strainers, etc.
 4. Multiple horizontal pipes, smaller than 12" diameter pipe, may be supported on trapeze hangers. Space trapeze hangers in accordance with the schedule for pipe spacing based upon the smallest size pipe.
 5. Properly size the trapeze members for the piping load they are to support. The number of pipes on the trapeze must be approved by the Engineer to prevent overloading of the building structure.
 6. Where pipes are insulated, oversize the hanger accordingly to accommodate the outside diameter of the insulation. Provide half-round 16 gauge galvanized steel shields, not less than 12" long and rolled to fit the insulation diameter, between the insulation and the hanger.
 7. When pipe is guided at top and bottom, cover the entire pipe circumference with metal shields.
 8. Adhere metal shield to the insulation so that the metal will not slide with respect to the insulation.
 9. Wood struts shall not be used to support piping in walls.

3.3 SLEEVES

- A. Above Grade and/or Dry Locations:
1. Walls:
 - a. Mount flush on both sides.
 2. Floors:
 - a. Mount 2 inches above finished floor in pipe chases.

- B. Passing Through Fire-Rated Enclosure:
 - 1. Fill the void space around the pipe in accordance with NFPA requirements.
 - 2. Do not allow the sleeve installation to lower the fire rating of the assembly.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Identification required for mechanical systems.
- B. Code required identification not shown on plans nor specified herein shall be provided.

1.3 RELATED SECTION

- A. Section 23 00 00 – Basic Mechanical Requirements

1.4 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.
- B. Submit wording of nameplates with submittals.
- C. Submit list of all products incorporated in this section.

1.5 REFERENCES

- A. Comply with ANSI A13.1
- B. USAS Code B31.8
- C. NTSB-PSS-73-1
- D. AGA

1.6 DESCRIPTION OF WORK

- A. Nameplates and tags are to be provided for all mechanical equipment and piping in the project. Identification is also required for the following, but is not limited to:
 - 1. Air Handlers
 - 2. Boilers/Water Heaters
 - 3. Condensing Units
 - 4. Duct Dampers
 - 5. Filter Sizes for Air Handlers
 - 6. Fire Dampers
 - 7. Heat Exchangers
 - 8. Piping
 - 9. Supply/Exhaust Fans
 - 10. Valves

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Seton
- B. Brady
- C. MSI

2.2 EQUIPMENT LABELS

- A. Type: Engraving-Stock, melamine plastic laminate, 3 layer.
 - 1. Thickness:
 - a. Less than 25 square inches: 1/16 inch
 - b. 25 square inches or more: 1/8 inch
- B. Color:
 - 1. Black
- C. Conform to FS L-P-387A

2.3 LETTERING

- A. Style:
 - 1. Engraved standard print.
- B. Size:
 - 1. 3/16 inch to 1/4 inch
- C. Color:
 - 1. White letters, black background

2.4 NAMEPLATE/TAG INFORMATION

- A. HVAC Equipment:
 - 1. Unit mark from Drawings/Owner
 - 2. Voltage - Phase
 - 3. Manufacturer and Model Number
 - 4. Filter size

2.5 NAMEPLATE FASTENERS

- A. Securely attach nameplates to equipment with non-corroding stainless steel screws.
- B. Non-corroding pop rivets are acceptable.
- C. Stick-ons or adhesives will not be allowed.

2.6 IDENTIFICATION OF PRODUCTS

- A. Provide pipe markers with the following features.
 - 1. Letters from 1/2" to 3-1/2"; size letters to afford readability from the appropriate viewing position.
 - 2. Repeated and reversed words for viewing from 360° around pipe.

3. Self-clinging, coiled markers that snap into place around pipe and do not require any other securement.
 4. Integral directional arrows.
- B. Letters on Field:
1. Identify the specific material conveyed. (i.e. "Domestic Cold Water", "Sprinkler", etc.)
- C. Model:
1. Less than 3/4":
 - a. Tags: Piping System Devices, color codes for hazard.
 2. 3/4" up to 6"; snap-on.
 3. Over 6"; strap-on, with stainless steel spring straps.
 4. Use tags and/or nameplates that are scratch resistant and UV resistant for outdoor equipment and piping.
- D. Piping System Devices (Valves, Thermometers, Pressure Gages, etc., and Pipe Less Than 3/4"):
1. Identify with the following:
 - a. Tags:
 - (1) Not less than 1-1/2 inch brass or aluminum tags, round, square, or octagonal.
 - b. Stamp tags with minimum 1/2" high descriptive characters, 1/2" high numbers with black enamel-filled indentations.
- E. Attachment:
1. Stainless steel or solid brass jack chain, or stainless steel or brass "S" hooks
- F. Ductwork:
1. Stenciled letters or self-adhesive labels, minimum 1" high characters.
 2. Red ribbon at each balancing damper.
- G. Underground Warning Tapes:
1. Provide materials that meet the codes or have the approvals listed below:
 - a. Office of Pipeline Safety Regulation, USAS Code B31.8.
 - b. GSA Public Building Service Guide Specification.
 - c. National Transportation Safety Board Report NTSB-PSS-73-1.
 - d. AGA Report 72-D-56.
 - e. API Report API RP 1109.
 2. Material:
 - a. Plastic, continuous tape, color-coded, marked for hazard.
 - b. For Non-metallic Piping System:
 - (1) Aluminum foil core encased in plastic.
 - c. Metallic Piping:
 - (1) Plastic tape.
 3. Color:
 - a. Colored (not printed color) plastic, coded for material conveyed by piping.
 4. Width:
 - a. As scheduled for piping system burial depth.
 5. Legend:
 - a. "Caution [System Name] Line Buried Below".
 6. Tape Colors:

Utility	Color
Natural Gas, Oil, Dangerous Materials	Hi Visibility Safety Yellow
Communications	Safety Alert Orange
 7. Model:
 - a. Metallic Piping System:
 - (1) Polyethylene Tape.

- b. Non-Metallic Piping System:
 - (1) Metallic Detection Tape.
- H. Underground Gas Piping:
 - 1. Attach No. 18 gauge copper tracer wire to the piping and terminate above grade at each end.
- I. Pipeline Markers for Pipe Beneath Pavement and Slabs:
 - 1. Minimum 2" round, square, or octagonal, same as specified in Subparagraph: Piping System Devices.
- J. Attachment:
 - 1. 1-1/2" screw, bolted to tag as anchor.
 - 2. Anchor Setting Compound:
 - a. Epoxy or epoxy grout, compatible with the pavement.

PART 3 EXECUTION

3.1 GENERAL

- A. Contractor shall verify room numbers with Owner/Engineer before nameplates are fabricated.
- B. The following shall be permanently and clearly identified:
 - 1. Each air handler, condensing unit, compressor, exhaust fan, and pump.
 - 2. Each zone duct, outside air duct, and return air duct whose duty is not immediately apparent.
 - 3. Each valve whose service and/or duty is not immediately apparent.

3.2 INSTALLATION

- A. Install signs on non-removable panels. Attach to equipment with pop rivets or stainless steel screws.
- B. Mount in an easily visible location.
- C. All labeling identification shall conform to final room numbers. Coordinate with General Contractor, A/E and Owner to secure construction room numbers.
- D. Provide all additional signage required by local authority at no cost to the Owner.
- E. Provide filter sizes and quantity on all air handlers.
- F. Complete installation in accordance with ANSI A13.1 and manufacturer's installation instructions and with the Drawings. Fasten each unit securely in place with stainless steel screws.
- G. Equipment Labeling:
 - 1. Install on scheduled items of equipment, including the following:
 - a. Air conditioning equipment
 - b. Pumps
 - c. Control panels and major control components
 - d. Include Mark Number and descriptive name from Drawing and Specification schedules
 - e. Attach with corrosion resistant, stainless steel screws or pop rivets

- f. Install 1/2" diameter adhesive marker (color to be approved by A/E), and apply to T-bar below any mechanical equipment and fire dampers above lay-in ceiling.

H. Piping System Color Coding:

1. Designate for painter the following:
 - a. Types of piping services
 - b. Direction of flow
 - c. Other information required for proper identification.

I. Surfaces to be Painted:

1. Bare piping
2. Insulation covering of insulated piping

J. Paint according to the following schedule:

System	Pastel Color
Condenser Water	Green
Gas Piping on Roof	Black or as required by local authority having jurisdiction

K. Piping System Devices (Valves, Thermometers, Pressure Gages, etc.):

1. Identify with the following information:
 - a. System
 - b. Device number
 - c. Device Function

L. Device Chart:

1. Key devices to device chart
2. Give complete description of device function and system.

M. Key devices to drawings as follows:

1. Floor plans
2. Schematic drawings of piping systems

N. Underground Warning Tapes:

1. Tape Widths:

Piping Burial	Depth Tape Width
10"	2"
20"	3"
27"	6"
30"	9"
40"	12"
50" or more	18"

O. Recommended Tape Bury Depth:

1. Minimum Depth:
 - a. 6".
2. Distance Between Pipe and Tape:
 - a. Minimum 12".
 - b. Maximum Depth: 12".
3. Tie tape to pipe where pipe leaves the ground.

- P. Pipeline Markers for Pipe Beneath Pavement and Slabs.
1. Location:
 - a. Accuracy:
 - (1) Plus or minus 6" from piping centerline.
 - b. Flat Edge Pavement and Slabs:
 - (1) Set within 6" of pavement or slab edge.
 - c. Concrete Curbs:
 - (1) Set in top of curb.
 - d. Spacing:
 - (1) Each change in direction, each edge of pavement or slab, maximum spacing of 100'.
 2. Legend:
 - a. Same as tags plus an engraved or stamped line; set marker with line parallel to buried line.
 3. Attachment:
 - a. Drill hole for anchor bolt, full depth of bolt plus 1/2"; set full tag and bolt in epoxy, flush with pavement or slab.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Testing and balancing services for the heating, ventilating, and air conditioning (HVAC) systems of this project. Final approval of the balancing agency shall be by the Engineer.
- B. The balancing agency will have a contractual relationship with the General Contractor for the satisfactory execution of testing and balancing of the HVAC systems.
- C. The following are acceptable agencies:
 - 1. Austin Air Balancing Company, Austin (Phone: 512-477-7247)
 - 2. PHI Service Agency, Inc., Austin (Phone: 512-339-4757)
 - 3. Delta-T, Inc., Austin (Phone: 512-590-1051)
 - 4. Engineered Air Balance, San Antonio (Phone: 210-736-9494)

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 07 13 – Duct and Grille Insulation
- C. Section 23 09 13 – Programmable Control Devices for HVAC
- D. Section 23 31 13 – Metal Ductwork
- E. Section 23 34 16 – HVAC Fans
- F. Section 23 37 13 – Diffusers, Registers, and Grilles
- G. Section 23 81 26 – Split System HVAC Units

1.4 STANDARDS

- A. The balancing agency shall perform the services specified herein in accordance with the Associated Air Balance Council's National Standards, including revisions, to the date of the contract.
- B. All terms in this specification shall have their meaning defined as stated in the National Standards.
- C. If these specifications set forth more stringent requirements than the AABC National Standards, these specifications shall prevail.

1.5 QUALIFICATIONS OF THE BALANCING AGENCY

- A. The balancing agency shall be a member of the Associated Air Balance Council (AABC) and/or certified by the National Environmental Balancing Bureau (NEBB).
- B. To perform required professional services, the balancing agency shall have a minimum of one "Test and Balance Engineer" certified by the Associated Air Balance Council and/or the National Environmental Balancing Bureau (NEBB).
- C. This certified "Test and Balance Engineer" shall be responsible for supervision and certification for the total work herein specified.
- D. The balancing agency shall submit records of experience in the field of air and hydronic system balancing or any other data as requested by the Owner/Engineer. The supervisory personnel for the firm shall have at least five (5) years' experience, and be a full time employee for a minimum of six (6) months prior to the project. All employees used in this project shall be qualified technicians in this specific field.
- E. The balancing agency shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the balancing agency may be required by the Owner to determine the balancing agency's performance capability.
- F. The balancing agency shall have operated for a minimum of five (5) years under its current name.

1.6 DOCUMENTS

- A. The General Contractor will provide the balancing agency one copy of the following documents:
 - 1. Project drawings (mechanical sepia's if requested) and specifications.
 - 2. Reviewed construction revisions pertaining to the HVAC systems.
 - 3. Reviewed submittal data on HVAC equipment and systems to be installed by the Mechanical Subcontractor.
 - 4. Reviewed HVAC shop drawings.
 - 5. Reviewed HVAC wiring diagrams, control diagrams, and equipment brochures, as appropriate.

1.7 COORDINATION

- A. It will be necessary for the balancing agency to perform its services in close coordination with the Mechanical Subcontractor.
- B. The plans and specifications indicate meters, valves, dampers, and other devices for the purpose of adjusting the system to obtain optimum operating conditions. It will be the responsibility of the Mechanical Subcontractor to install these devices in a manner that will leave them accessible, readily adjustable and complete. The balancing agency shall provide guidance if there is a questionable arrangement of a control or balancing device.
- C. The General Contractor, Mechanical Contractor, Temperature Controls Subcontractor, and the suppliers of the HVAC equipment shall all cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.

1.8 RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

- A. The Mechanical Contractor shall complete the installation and start all HVAC systems to ensure they are working properly, and shall perform all other items as described hereinafter to assist the balancing agency in performing the testing and balancing of the HVAC systems.
- B. Air Distribution Systems:
 - 1. Verify installation for conformity to design.
 - 2. Terminate all supply, return, and exhaust ducts, and pressure test them, for leakage, as required by specification.
 - 3. Ensure that all splitters, extractors, and volume and fire dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
 - 4. Verify that all supply, return, exhaust, and transfer grilles; registers; diffusers; and high-pressure terminal units are installed and operational.
 - 5. Ensure that air-handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air.
 - 6. Ensure that all fans (supply, return, relief, and exhaust) are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.
 - 7. Make any necessary changes to the sheaves, belts, and dampers, as required by the balancing agency, at no additional cost to the Owner.
 - 8. Install clean filters.

1.9 RESPONSIBILITIES OF THE TEMPERATURE CONTROLS CONTRACTOR

- A. The Temperature-Controls Contractor shall allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.
- B. Furnish to the balancing agency any software and cables required to make adjustments to controls. Any unique micro-processor required to set controls shall be furnished by Temperature Controls Contractor.
- C. The Temperature Controls Contractor shall complete the installation of the temperature control system, and operate and test all control systems to ensure they are functioning properly as designed. The Temperature Controls Contractor shall assist the balancing agency in testing and balancing the HVAC systems, as described hereinafter.
 - 1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, and fire and freeze-stats.
 - 2. Verify that all controlling instruments are calibrated and set for design operating conditions.
 - 3. Calibrate room thermostats/sensors after installation, and before the thermostat control verification tests are performed. The balancing agency shall prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

1.10 PRE-BALANCING CONFERENCE

- A. Prior to beginning of the testing, adjusting and balancing procedures, schedule and conduct a conference with the Architect/Engineer, General Contractor, Mechanical Contractor, Electrical Contractor and Temperature Controls Contractor. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.11 NOTIFICATION FOR TESTING AND BALANCING WORK TO BEGIN

- A. The general contractor shall notify the balancing agency in writing when all heating, ventilating, and air conditioning systems are complete and ready for testing and balancing. The Mechanical Contractor shall attest that he has completed all items as described in "RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR" Section of these specifications.
- B. If, upon commencing the work, the balancing agency finds that the systems are not ready, or if a dispute occurs as to the readiness of the systems, the balancing agency shall request an inspection to be made by the Mechanical Engineer. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Should the inspection reveal the notification to have been premature, the balancing agency shall be reimbursed for all costs for the inspection and work previously accomplished. Furthermore, such items that are not ready for testing and balancing shall be completed and placed in operational readiness before testing and balancing services shall again be requested.

PART 2 PRODUCTS

- A. Not Applicable

PART 3 EXECUTION

3.1 SCOPE

- A. In accordance with Project Drawings and Specifications and as specified herein, the balancing agency shall provide all supervision, personnel, instruments, calibration equipment, and all other materials and services necessary to perform all testing and balancing of the heating, ventilating, and air conditioning systems. All test data including all pertinent calculations shall be reported on appropriate forms.

3.2 GENERAL

- A. The testing and balancing of the heating, ventilating, and air conditioning systems shall be performed by an independent balancing agency approved by the Engineer. The balancing agency shall have a minimum of five years specialized experience in air and hydronic system balancing, possess calibrated instruments, certified "Test and Balance Engineers", and skilled technicians to perform all required tests. The balancing agency shall be a certified member of the Associated Air Balance Council and/or the National Environmental Balancing Bureau (NEBB).
- B. The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. The balancing agency shall then make available to the Owner's representative such instruments and technicians as are required for spot checks of the system.

- C. The balancing agency shall not instruct or direct the Mechanical Contractor in any of the work. Any proposed changes or revision in the work shall be submitted to the Architect and General Contractor in writing.
- D. Document Review:
 - 1. The Test and Balance Firm shall be responsible for reviewing the HVAC plans and specifications relating to the test and balance services for proper arrangement and adequate provisions of devices for testing, adjusting and balancing.
 - 2. Test and Balance Firm shall review HVAC manufacturers' submittals data relative to balanceability.
 - 3. Test and Balance Firm shall review submitted HVAC automatic temperature control sequences for conformity to the specifications.

3.3 SERVICES

- A. During construction, the balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the heating, ventilating, and air conditioning systems.
- B. The inspections shall be performed periodically as the work progresses. A minimum of two inspections are required as follows: (1) when 60 percent of the duct work is installed; (2) when 90 percent of the equipment is installed. The balancing agency shall submit a brief written report of each inspection to the General Contractor and Engineer.
- C. Upon completion of the installation and start-up of the mechanical equipment by the Mechanical Contractor, the balancing agency shall test and balance the system components to obtain optimum conditions in each conditioned space in the building.

3.4 DEFICIENCIES

- A. If in the process of performing the TAB work, any deficiencies encountered shall be brought to the attention of the contractor responsible through defined procedures, and entered in the punch list of deficiencies on the next daily Status Report. If correction of the deficiency is urgent, the matter shall be brought to the attention of all involved parties for quick resolution. The General Contractor shall provide and coordinate services of qualified responsible subcontractors, suppliers and personnel as required to correct, repair or replace any and all deficient items or conditions during the testing, adjusting and balancing period.
- B. The notification may be for single or multiple deficiencies. The work necessary to correct items on the listing shall be performed and verified in writing by the affected trade.
- C. All deficiencies that prevent proper TAB work from being completed shall be corrected prior to submittal of the Final TAB Report, unless the correction of such deficiencies cannot be accomplished in a reasonable period of time, in which case the Mechanical Engineer may grant permission to submit the Final TAB Report with the deficiencies detailed in the report.

3.5 AIR SYSTEM PROCEDURES

- A. The balancing agency shall perform the following testing and balancing functions in accordance with the Associated Air Balance Council's National Standards:
 - 1. Fan Speeds:
 - a. Test and adjust fan RPM to achieve design CFM requirements.
 - 2. Current and Voltage:
 - a. Measure and record motor current and voltage.

3. Pitot-tube Traverse:
 - a. Perform a Pitot-tube traverse of main supply and return ducts to obtain total CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation why a traverse was not made must appear on the appropriate data sheet.
4. Outside Air:
 - a. Test and adjust system minimum outside air by Pitot-tube traverse. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures. Make allowances for heat of compression and motor heat where applicable.
5. Static Pressure:
 - a. Test and record system static pressures, including suction and discharge static pressure of each fan.
6. Air Temperature:
 - a. Take wet-bulb and dry-bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.
7. Zone Ducts:
 - a. Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
8. Main Ducts:
 - a. Adjust main ducts to within design CFM requirements and traverse for total CFM quantities.
9. Branch Ducts:
 - a. Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
10. Tolerances:
 - a. Test and balance each diffuser, grille, and register to within 10 percent of design requirements.
11. Identification:
 - a. Identify the location and area of each grille, diffuser, register, and terminal box. This information shall be recorded on air outlet data sheets.
12. Description:
 - a. Record the size, type, and manufacturer of each diffuser, grille, and register on air outlet data sheets.
13. Terminal Boxes:
 - a. Set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements. All associated temperature controls shall be checked for proper operation and calibration. If the terminal boxes have separate settings for heating and cooling CFM, the CFM quantities for each shall be recorded on air outlet data sheets. All diffusers connected to the terminal box shall be read in the heating and cooling modes and their readings recorded on air outlet data sheets.
14. Minimizing Drafts:
 - a. Adjust all diffusers, grilles, and registers to minimize drafts in all areas.

3.6 VERIFICATION OF TEMPERATURE CONTROL

- A. The balancing agency shall be assisted by the Temperature Controls Contractor in verifying the operation and calibration of all temperature control systems. The following tests shall be conducted:
 1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, and fire and freeze stats.
 2. Verify that all controlling instruments are calibrated and set for design operating conditions.

3. Verify the accuracy of the final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.
- B. In the process of performing the TAB work, the balancing agency firm shall:
 1. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
 2. Verify that all dampers and valves are in the position indicated by the controller (open, closed, or modulating).
 3. Verify the integrity of valves and dampers in terms of tightness of close-off and of full-open position. This includes dampers in VAV terminals.
 4. Check that all valves are properly installed in the piping system in relation to direction of flow and location.
 5. Verify the proper application of all normally open and normally closed valves.
 6. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold/hot walls.
 7. Check the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media.
 8. Check the sequence of operation for any control mode to ensure that it is in accordance with the Contract Documents.
- C. Verify that all controller set points meet the design intent. Record observations of systems under DDC control. Record all default set points if different from operating set points.
- D. Check all dampers for free and full operation, record any obstructions.
- E. Verify the operation of all interlock systems.
- F. Perform all system verifications to assure the safety of the system and its components.
- G. Verify that the changeover from heating to cooling mode occurs as specified.

3.7 TEST AND BALANCE REPORT

- A. The test and balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound and submitted in a single PDF file. The report shall be certified, accurate and complete by the balancing agency's certified Test and Balance Engineer.
- B. The report shall contain the following general data in a format selected by the balancing agency:
 1. Project number
 2. Contract number
 3. Project title
 4. Project location
 5. Project Architect
 6. Project Mechanical Engineer
 7. Test & Balance agency
 8. Test & Balance Engineer
 9. General Contractor
 10. Mechanical Subcontractor
 11. Dates tests were performed
 12. Certification
- C. The test and balance report shall be recorded on report forms conforming to the recommended forms in the AABC National Standards. At a minimum, the report shall include:
 1. Preface

2. A general discussion of the system, any abnormalities and problems encountered.
3. Instrumentation list
4. The list of instruments including type, model, manufacturer, serial number, and calibration dates.
5. Data
6. All test and balance data indicating design and actual conditions of operation for each device and/or piece of HVAC equipment.
7. System Identification
8. In each report, the VAV boxes, zones, supply, return, and exhaust openings, and traverse points shall be numbered and/or lettered on mechanical drawings to correspond to the numbers and letters used on the report data sheets.
9. Controls
10. Document verification of controls.
11. Occupancy Inspection
12. Make a total of three (3) inspections within ninety (90) days after occupancy of the building, and make adjustments if required, to insure that satisfactory conditions are being maintained throughout. Inspections to be coordinated with Architect/Engineer and Owner and shall be documented with a supplemental report containing data and information as required.
13. Instructions to Operating Personnel
14. Test and Balance Firm shall instruct the operating personnel regarding the following:
 - a. Systems Operation
 - b. Unusual Operating Conditions.
 - c. System Troubleshooting Procedures.

3.8 REPORT SUBMITTAL

- A. The test and balance report are required and shall be submitted to the General Contractor for distribution to the Owner, Architect and Mechanical Engineer. The test and balance report shall be submitted in a single, fully bound PDF file.

3.9 FINAL ACCEPTANCE

- A. At the time of final inspection, the balancing agency shall recheck, in the presence of the Owner's representative, specific and random selections of data recorded in the certified test and balance report.
- B. Points and areas for recheck shall be selected by the Owner's representative.
- C. Measurements and test procedures shall be the same as the original test and balance.
- D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.
- E. If random tests demonstrate a measured flow deviation of 10 percent or more from that recorded in the certified test and balance report, the report shall automatically be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance report submitted, and a new inspection test made, all at no additional cost to the Owner.

3.10 OPPOSITE SEASON TEST

- A. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

END OF SECTION

SECTION 23 07 13

DUCT AND GRILLE INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. External duct insulation
- B. Internal duct liner

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 31 13 – Metal Ductwork
- C. Section 23 37 13 – Diffusers, Registers, and Grilles

1.4 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 01.
 - 2. Submit product data indicating typical catalog of information.
 - 3. Submit product data sheets indicating dimensions, general assembly, and ratings.
 - 4. Submit manufacturer's installation instructions.
 - 5. Submit kitchen exhaust duct wrap to City for approval prior to submitting to Engineer.

1.5 REFERENCES

- A. Refer to Section 23 00 00 for complete names of references identified in this section.

ASTM E84	Standard test for surface burning characteristics of building materials.
NFPA 221	Fire walls and fire barrier walls.
NFPA 255	Surface burning characteristics of building materials.
NFPA 96	Ventilation control and fire protection of commercial cooking operations.
UL 723	Test for surface burning characteristics of building materials.
UL 1978	First Edition Standard for Grease Ducts
ASTM C553	Standard specification for mineral fiber blanket thermal insulation for commercial and industrial applications.
ASTM C1071	Fibrous glass duct lining insulation (thermal and sound).
IECC	International Energy Conservation Code
ASTM C355	Water Vapor Permeance
ASTM C916-85(2001)e1	Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C1136-02	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

ASTM A635/A635M-02	Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, Hot-Rolled, General Requirements
ASTM A924	Hot Dip Galvanized Coils & Sheets - Tolerances

1.6 QUALITY ASSURANCE

- A. Fire Hazard Rating:
 - 1. All insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E84, NFPA 255 and UL 723. Bear UL label. All insulation must meet ASTM C553.
 - 2. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive.
 - 3. Components such as adhesives, mastics and cements must meet the same individual ratings as minimum requirements.
 - 4. Install in accordance with SMACNA standards.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original sealed containers or unopened packages, and clearly labeled with manufacturer's name, product identification, and lot numbers.
- B. Store materials out of weather and in an enclosed shelter.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. Supply ducts
- B. Return ducts
- C. Outside air ducts
- D. Supply and return diffusers
- E. Grilles
- F. Registers with exposed surfaces in unconditioned areas
- G. General exhaust ducts do not receive insulation

2.2 MANUFACTURERS

- A. Owens Corning
- B. Knauf
- C. Johns Manville

2.3 EXTERNAL DUCT WRAP AND GRILLE INSULATION

- A. Minimum Density:
 - 1. 3/4 pound per cubic foot
- B. Material:
 - 1. Fiberglass blanket with type FRK foil reinforced Kraft vapor barrier jacket
- C. Thickness:
 - 1. 2.0 inch, Minimum Value R-6.0
- D. Comply with ASTM C553 standard
- E. Comply with ASTM C1136-02
- F. Comply with ASTM E84
- G. Comply with IECC

2.4 INTERNAL DUCT LINER

- A. Use only where specifically noted, or with written approval of Engineer.
- B. Install internal duct liner that extends no more than 2'-0" below roof deck at each rooftop unit.
- C. Thickness:
 - 1. 1½ inch thick, Minimum Value R-6.0
- D. Fasteners:
 - 1. Pronged straps.
- E. Comply With ASTM C916-85(2001)e1
- F. Comply with ASTM C1071 standard
- G. Comply with ASTM C553 standard
- H. Comply with ASTM C1136-02
- I. Comply with ASTM E84
- J. Comply with IECC

PART 3 EXECUTION

3.1 DUCT WRAP INSTALLATION

- A. Wrap insulation tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 3 inches.
- B. Adhere insulation to metal with 4 inch strips of insulation bonding, using adhesive at 8 inch centers.
- C. On circumferential joints, secure the 2-inch flange of the facing and tape with a minimum of 3 inch wide foil reinforced Kraft tape.

- D. On longitudinal joints, secure the overlap using 9/16 inch flared door staples applied 6 inches on centers and taped with minimum 3 inch wide foil reinforced Kraft tape.
- E. Tape all pin penetrations or punctures in facing.
- F. The duct wrap insulation on all rectangular/square ducts 24-inch or wider shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers. Spacing at 18-inch on center each direction to prevent sagging.
- G. Fasten insulation installed on diffusers, grilles, and registers using 3-inch minimum wide foil reinforced Kraft tape.
- H. Extend insulation 1 inch beyond each outer surface of diffuser, grille, and register.

3.2 INTERNAL DUCT LINER

- A. Provide internal duct liner as indicated on the plans.
- B. Install internal duct liner on rooftop unit supply and return ducts no more than 2'-0" below roof deck.
- C. Apply the liner to the inside of the duct with heavy density side to the air stream and secure to the duct with adhesive Insul-Coustic No. 225 completely coating the clean sheet metal.
- D. Do not use duct liner in kitchen or other areas that may have excess moisture present.
- E. Secure fasteners to the ducts with adhesive.
- F. Conform to SMACNA Standards for all duct construction standards.
- G. Accurately cut the liner and thoroughly coat the ends with adhesive to make a firmly butted and tightly sealed joint.
- H. Where ducts are lined, exterior insulation will not be needed except as otherwise specified.
- I. Install duct liner in accordance with SMACNA standards.

END OF SECTION

SECTION 23 07 21

REFRIGERANT PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Elastomeric closed-cell structure insulation
- B. Applications – Refrigerant suction lines serving cooling units

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 23 00 – Refrigerant Piping

1.4 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
 - 2. Submit product data indicating typical catalog of information.
 - 3. Submit product data sheets indicating dimensions, general assembly, and ratings.
 - 4. Submit manufacturer's installation instructions.

1.5 SHOP DRAWINGS

- A. Submit 1/4" per foot shop drawing(s) showing all piping and equipment shown by plans and specifications. The drawings shall be coordinated with structural, electrical, and fire sprinkler drawings.

1.6 REFERENCES

- A. Refer to Section 23 00 00 for complete names of references identified in this section.
- B. ASTM E 84-03 - Standard Test Method for Surface Burning Characteristics of Building Materials
- C. ASTM C 355 - Water Vapor Permeability

1.7 QUALITY ASSURANCE

- A. Fire Endurance Rating: The composite classifications shall not exceed the flame spread rating and the smoke development rating as outlined by NFPA 255/ ASTM E-84 for the basic material, the finishes, adhesives, etc., specified for each system, and shall be such when completely assembled.
- B. Components such as adhesives, mastics and cement must meet the same requirement.

PART 2 PRODUCTS

2.1 PIPE INSULATION

- A. Type: Closed-cell polyethylene pipe insulation.
- B. Performance Criteria: Resistant to ultra-violet and biological degradation.
- C. Temperature Range: -90°F to 212°F
- D. Water Vapor Permeability (Dry Cup): Less than 0.03 per inch when measured by ASTM C355.
- E. Thermal Conductivity: 0.265 BTU-IN/HR-FT²-°F or less at 75°F mean temperature.
- F. Refrigerant Suction Lines Insulation thickness – 1½-inches
- G. Manufacturer/Model:
 - 1. Armacell
 - 2. Aeroflex

2.2 SEALANT & ADHESIVE

- A. Manufacturer/Model:
 - 1. Therma-Cel
 - 2. Armstrong
 - 3. Aeroflex

2.3 FINISHES

- A. Manufacturer:
 - 1. WB Armstrong Finish – White
 - 2. Aeroflex
 - 3. VentureClad

PART 3 EXECUTION

3.1 PIPE

- A. Where straps or hangers are used, provide insulation shield.
- B. Apply insulation to clean, dry pipes.
- C. Butt insulation joints firmly together.
- D. Seal butt seams with sealant. Duct tape or electrical tape will not be permitted.
- E. Install in accordance with manufacturer's instructions.
- F. Accomplish in a good workmanship manner and be neat in appearance.
- G. Insulation not neat in appearance will be rejected by the Engineer.
- H. Do not stretch insulation around elbows.

- I. Install insulation on piping prior to final connection.
- J. Longitudinal joints installed after pipe is assembled are not acceptable.
- K. Refer to plans for installation of shields around pipe hangers.
- L. Do not allow liquid lines to come in contact with any structural members or steel stubs. Use plastic ties to secure liquid lines to insulation on vapor line. Do not crush insulation.

3.2 FINISH

- A. All insulation to be painted with WB Armstrong Finish, or equivalent. Apply as recommended by the manufacturer, to protect the insulation on exterior of building. Apply above 50°F. Apply to dry insulation only.

3.3 VALVES, FLANGES & FITTINGS

- A. Insulate all valves, flanges, and fittings in a neat manner.

3.4 REPAIRS & REPLACEMENT

- A. Replace any insulation that has ever been wet.
- B. Repair any damage caused by condensation due to improper insulating.
- C. Replace any insulation which is cut or torn during construction.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
- B. Division 01 section 'Building Systems Commissioning'.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Mechanical systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "Building Systems Commissioning" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "Building Systems Commissioning" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "Building Systems Commissioning" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "Building Systems Commissioning" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "Building Systems Commissioning" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the mechanical systems and controls systems in Division 23. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 – EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Functional Testing Forms for all commissioned components, equipment, and systems.
- B. Red-lined Drawings:
 - 1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 - 2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 - 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
 - 4. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data:
 - 1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
 - 2. The CxA will review the O&M literature once for conformance to project requirements.
 - 3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

- D. Systems manual requirements:
 - 1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 - 2. The GC shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Schematics
 - b. Verified Record Drawings
 - c. Test Results (not otherwise included in Cx Record)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
 - 3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.
 - 4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Mechanical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Mechanical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner.
- G. Update schedule as required throughout the construction period.
- H. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- I. Assist the CxA in all verification and functional performance tests.
- J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- L. Participate in, and schedule vendors and contractors to participate in the training sessions.

- M. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.

Cx Systems	Require Fx Testing	Items Tested
HVAC		
___ Chilled Water Plants	Yes	Controls, Sequence of Operations, Alarms
___ Hot Water Plants	Yes	Controls, Sequence of Operations, Alarms
___ Air Handling Units	Yes	Controls, Sequence of Operations, Alarms, Economizer
___ Packaged Units (RTU and HP)	Yes	Controls, Sequence of Operations, Alarms, Economizer
___ Terminal Units/VAV's	Yes	Controls, Sequence of Operations, Alarms, Economizer
___ Exhaust and Relief fans	Yes	Controls, Sequence of Operations, Alarms
___ DDC Control System (<i>Component installation and System Operation</i>)	Yes	System calibration and function

- N. The equipment supplier shall document the performance of his equipment.
- O. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
- P. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- Q. Equipment Suppliers
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 2. Assist in equipment testing per agreements with contractors.
 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
- R. Refer to Division 01 Section "Building Systems Commissioning" for additional Contractor responsibilities.

3.3 OWNER'S RESPONSIBILITIES

- A. Refer to Division 01 Section "Building Systems Commissioning" for Owner's Responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01 Section "Building Systems Commissioning" for Design Professional's Responsibilities.

3.5 CXA'S RESPONSIBILITIES

- A. Refer to Division 01 Section "Building Systems Commissioning" for CxA's Responsibilities.

3.6 TESTING PREPARATION

- A. Certify in writing to the CxA that Mechanical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that Mechanical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Mechanical testing shall include sequence of operations for HVAC equipment, HVAC building automation control system, economizers; etc.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the Mechanical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.8 MECHANICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Functional Performance Tests: Sample functional performance testing procedures are included in Part 3.13. These procedures are representative of those that will be implemented in the Cx process. The CxA may modify these procedures during the Construction Phase once all systems are known and all required documentation has been provided.
- B. Mechanical Instrumentation and Control System Testing: Assist the CxA with preparation of testing plans.

3.9 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section “Building Systems Commissioning” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.10 APPROVAL

- A. Refer to Division 01 Section “Building Systems Commissioning” for approval procedures.

3.11 DEFERRED TESTING

- A. Refer to Division 01 Section “Building Systems Commissioning” for requirements pertaining to deferred testing.

3.12 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section “Building Systems Commissioning” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.13 SAMPLE FUNCTIONAL PERFORMANCE TESTING PROCEDURES

- A. These testing procedures are representative of those that will be implemented in the Cx process. The CxA may modify these procedures during the Construction Phase once all systems are known and all required documentation has been provided.

Example Systems

ELECTRONIC FILE NAME

AHU

AHU-FT

Functional Test Record- _____		
Project Owner: _____		
Project Type: _____		
Project Address:		
List Building Systems to Test:		
CH-1 & CH-2	Cooling Only VAV Terminal	Generator Run Status
BL-1 & BL-2	Electrical Room Exhaust Fans	Lighting
AHU-A1, A2, B1, B2, C1, C2, D1, D2	Boiler Room Supply Fan	Fire Alarm Monitoring
AHU-B3, E1, E2	Packaged Computer Room Units (MDF/IDF)	Utility Monitoring
AHU-E3	Freezer/Cooler	Relief Dampers
OAHU-A1, B1, E1	Kitchen Exhaust/Supply Fans	Power Monitoring
FCU-1	Dishwasher Exhaust	Outside Air Conditions
Constant Volume Terminal Unit with Hot Water Reheat	Building Emergency Shutdown	
Constant Volume Terminal Unit with Electric Reheat	General Exhaust Fans	
Beginning O. A. Temp: _____ (F)	Ending O.A. Temp: _____ (F)	% RH: (HI) _____ (LO) _____

List Weather conditions at the project site: Mostly dry conditions with a short shower.			
List Controls and HVAC Testing Spec Sections:			
Building Environmental Conditions:			
☐ Clean ☐ Dirty ☐ Dry ☐ Wet ☐ Other In Construction			
Verify the following conditions prior to testing	Yes	No	If <u>No</u> is checked, list reason
☐ AHU/O.A/CV Boxes have clean filters installed	☐	☐	
☐ Final Filters are as specified	☐	☐	
☐ Ductwork protective covers have been removed	☐	☐	
☐ TAB is Complete for systems being tested	☐	☐	
☐ Controls are complete and system is controlled from DDC control panel/laptop	☐	☐	

Verify the following documentation requirements have been met prior to testing	Yes	No
Checklists have been sampled for review by the CxA to determine the operational readiness for systems being tested	☐	☐
TAB <u>Draft Field Report</u> has been reviewed and all know TAB deficiencies are corrected or noted by the Cx Agent	☐	☐
Controls Contractor completed Pre-Commissioning Checklist has been reviewed by the CxA	☐	☐
General Contractor has been notified of the CxA scheduled testing dates and times. This is related to coordination with Life Safety Systems testing by the AHJ or Fire Marshal.	☐	☐
All issues identified and recorded on the Cx Issues Log or reported to the GC have been resolved	☐	☐
COMMISSIONING CHECKLISTS:		
☐ REVIEWED by CxA ☐ COMPLETE ☐ INCOMPLETE		
TAB FIELD REPORT:		
☐ SUBMITTED ☐ NOT SUBMITTED		
☐ REVIEWED ☐ NOT REVIEWED		
CEILING SYSTEMS/GRID INSTALLED IN ALL AREAS UNDER TEST		
☐ YES ☐ NO		
LIGHTING SYSTEMS:		
☐ INDOOR ☐ EXTERIOR ☐ SITE ☐ NOT TESTED		
☐ INSTALLED ☐ FULLY OPERATIONAL ☐ PRE-TESTED BY CONTROLS SUB		
☐ NOT INSTALLED ☐ NOT FULLY OPERATIONAL ☐ NOT PRE-TESTED		

COMMENTS:					
CxA Note: Items found noncompliant, incomplete, in variance to the contract documents or fail to perform as intended per the contract documents and engineer approved control sequences, will be documented in writing, and the GC, Owner's PM and Engineer of record will be notified of the discrepancy. The GC will be responsible for ensuring his sub-contractors resolve issues reported, in a timely manner and to notify the CxA that the system is made ready for Functional Retest.					
Building Occupied/Unoccupied Schedule:					
Day of Week	Area	System Enabled	Occ	Syst. Disabled	Un-Occ
Monday - Friday	Admin	6:00 AM	7:00 AM	3:30 PM	4:00 PM
	Classrooms				
	Gym				
	Cafeteria				
	General Spaces				
Weekend	Scheduled as requested per facility request				
Holidays	Scheduled as requested per facility request				
Note:					
Optimum Start Program:	Yes	No	Comments		
Yes					
No					
Required	☐	☐			
Programmed	☐	☐			

Designated Temperature Setpoints:						
Occupied:						
Cooling Setpoint °F	<u>74 +/- 1°</u>					
Heating Setpoint °F	<u>69 +/- 1°</u>					
Unoccupied:						
Cooling Setpoint °F	95					
Heating Setpoint °F	55					
Night Setback						
Setpoint °F	95/55					
CxA Note: Testing sequences may be conducted simultaneously where systems are connected or operate in conjunction with one another. This includes Chillers, Boilers, AHU's, TU's and Exhaust fans.						
Testing Sequence						
Variable Volume Air Handling Unit Sequence of Operation	Pass	Fail	Note			
Unit: VAV AHU #		-	-			
		-	-			
Fan Control		-	-			
When the air handling unit is requested to run, the BAS shall start the fan. A current switch shall prove status to the BAS and shall alarm at the central site if the switch is not made within 40 seconds (adjustable).		-	-			
		-	-			

Cold Deck Temperature Control		-	-
When the air handling unit is in occupied mode and cooling is required, the BAS shall send a request for cooling to the chiller plant and shall modulate the chilled water control valve to maintain leaving air temperature set point (55 °F, adjustable).		-	-
			-
Air Volume Control		-	-
While the air handling unit is active, the BAS shall maintain the duct static pressure set point at 1.5" w.g. (adjustable) by modulating the speed of the supply fan through a variable speed drive (VSD). A static pressure sensor, mounted two-thirds down the longest duct run, shall monitor the duct static pressure. A manual-reset static pressure high limit switch, shall monitor the static pressure of the supply ducts. If the duct static pressure rises above 3.0" w.g. (locally adjustable) the air handling unit shall be de-energized via hard-wire interlock to the VFD safety circuit. The BAS shall monitor the high static limit switch and shall display an alarm at the central site. The static pressure high limit switch must be manually reset.		-	-
			-
Demand Control Ventilation		-	-
When the air handler is running in the occupied mode, the OA damper control shall be enabled. CO2 sensors mounted as indicated on drawings, shall monitor the CO2 levels. Where multiple sensors are provided for a particular AHU, the BAS shall select the highest level for control. The BAS shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO2 level between 850 ppm and 1000 ppm (all adjustable). The OA dampers minimum and maximum positions shall be determined by the T.A.B. contractor to be the positions that allow the scheduled minimum and maximum OA CFM. The system shall have the ability to perform a "Purge Mode" at a scheduled time for a scheduled duration. The BAS will monitor Outside Airflow via the Airflow Monitoring Station.		-	-
			-

Humidity Control		-	-
The BAS shall monitor humidity in 2 representative zones for each AHU. If either humidity transmitter senses humidity above 55% (adjustable), the BAS shall command 40% of the associated terminal units to 100% cooling (adjustable), and the terminal unit controller shall utilize the terminal unit reheat to maintain space setpoint.		-	-
		-	-
Auxiliary DX Cooling Coil (If Available)		-	-
The air handling unit serving the administration area shall be provided with an auxiliary DX cooling coil in addition to the hydronic coil. When the system is operating after hours, the BAS shall utilize the DX cooling for supply air temperature control and shall not send a request to the chiller plant.		-	-
		-	-
Reversed valve, DX coil not started up			-
Associated Equipment		-	-
During the occupied time period, any associated exhaust fans shall be energized.		-	-
		-	-
End of Testing			

END OF SECTION

SECTION 23 09 13

PROGRAMMABLE CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Programmable Thermostats for use in controlling heating and/or cooling units.
- B. Relative humidity sensors to control dehumidification mode.
- C. CO₂ sensors to control outside air damper positioning.

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

1.4 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

PART 2 PRODUCTS

2.1 TYPE

- A. Programmable Commercial Thermostat

2.2 CONSTRUCTION

- A. Complete with sub-bases

2.3 FEATURES

- A. Seven-day flexible programming
- B. Full feature Liquid Crystal Display
- C. Proportional plus Integral (P+I) control
- D. Concealed keyboard lockout switch and locking cover
- E. Automatic heat/cool changeover
- F. Built-in HVAC equipment protection (with minimum on and off times)

- G. Three-hour override of unoccupied program
- H. Continuous unoccupied key
- I. Comfort adjust feature
- J. Battery backup
- K. Controllers with temperature, humidity, and CO₂ control combined in a single controller are acceptable.
- L. WiFi enabled thermostat that allows remote access via Tablet or Smartphone.
- M. Tablet or Smartphone application must be capable of controlling and monitoring an unlimited number of thermostats.

2.4 MANUFACTURER AND MODEL

- A. HVAC Manufacturer's Thermostat (Preferred)
- B. Honeywell

PART 3 EXECUTION

3.1 INSTALLATION

- A. Replace existing non-programmable thermostats with programmable thermostats.
- B. Install in accordance with manufacturer's instructions.
- C. If HVAC Manufacturer's thermostat is not used, it is the responsibility of the contractor to verify that all modes of cooling, heating, dehumidification, and outside air damper positioning can be properly controlled with the controls provided.
- D. Programmable thermostat must "learn" appropriate warm up and cool down start times in order for space occupied setpoint to be reached at occupied start time. Unit shall not begin warm up/cool down at occupied start time.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Refrigerant piping for split system (including heat pumps) cooling/heating units.

1.3 RELATED SECTIONS

- A. Section 22 05 30 – Pipe and Pipe Fittings - General
- B. Section 23 00 00 – Basic Mechanical Requirements
- C. Section 23 07 21 – Refrigerant Piping Insulation
- D. Section 23 33 33 – Access Doors

1.4 REFERENCES

- A. ASTM B280 - Seamless Copper Tube for Air Conditioning & Refrigeration Service

1.5 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

1.6 COORDINATION

- A. Coordinate the refrigerant line sizing, lengths, traps, and all other aspects of the refrigerant systems with the air conditioning unit manufacturer to ensure a completely working and reliable system.
- B. Submit product data on piping materials and fittings.
- C. Provide letter stating air conditioning manufacturer has reviewed refrigerant line design. Provide drawings on any lines that are longer than 80 feet.
- D. If units have to be moved due to line lengths, then all associated costs will be at the Contractor's expense.

PART 2 PRODUCTS

2.1 PIPING

- A. ACR hard drawn copper tubing, conform to ASTM B280.

2.2 FITTINGS

- A. Wrought copper fittings
- B. Use silver solder at connections

2.3 VALVES

- A. Manufacturers:
 - 1. Alco Controls
 - 2. Sporlan Valve Company

PART 3 EXECUTION

3.1 MATERIAL PREPARATION

- A. Cut tubing with a sharp pipe cutter.
- B. Ream and thoroughly clean to remove all burrs, filings, dirt and grease before assembly and soldering.
- C. Remove oxide and discoloration prior to assembly.

3.2 SLEEVES

- A. Sleeve piping as required in accordance with Section 23 05 29 – Pipe and Pipe Fittings.
- B. All refrigerant piping passing under slab shall be sleeved.
- C. Sleeves shall be of an adequate size to permit removal of the piping at a later date.

3.3 HANGER SUPPORTS

- A. Support as required in accordance with Section 23 05 29 – Pipe and Pipe Fittings.
- B. Do not fasten liquid and suction lines together unless there is insulation between them. Use wire ties. Duct tape not allowed.
- C. Insulate all refrigerant lines from structure.

3.4 INSTALLATION

- A. Route with building lines, vertical lines to be plumb, grade horizontal suction lines to compressor.
- B. All brazing shall be done with 2-8 psig dry nitrogen purge.
- C. Protect all valves and paint from excessive heat.
- D. Keep refrigerant lines sealed from atmosphere during construction.

- E. All suction lines to receive insulation.
- F. No welded or mechanical joints in concealed areas, such as walls.
- G. Follow A/C manufacturer's instructions.

END OF SECTION

SECTION 23 31 13

METAL DUCTWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Furnishing and installation of all ductwork as shown on the construction documents. Acoustical and thermal linings and wrappings; flexible ductwork and connections; combination smoke and fire dampers, smoke dampers, and fire dampers; duct access doors; air diffusers, grilles and registers; air volume control devices; hangers and supports; plenums and casings; turning vanes; air filters; installation of temperature control dampers, and other appurtenances necessary for a complete and operational system.
- B. All work shall be preceded by taking measurements at the job site, fully coordinating all work with other disciplines, verifying available spaces for ductwork, and developing shop drawings.

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
- C. Section 23 07 13 – Duct and Grille Insulation
- D. Section 23 33 33 – Access Doors
- E. Section 23 34 16 – HVAC Fans
- F. Section 23 37 13 – Diffusers, Registers, and Grilles
- G. Section 23 81 26 – Split System HVAC Units

1.4 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters
- B. AMCA 511 - Certified Ratings Program for Air Control Devices
- C. ASTM 653 - Sheet Metal, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanized) by the Hot-Dipped Process
- D. ASTM A924 - Hot Dip Galvanized Coils & Sheets – Tolerances
- E. ASTM A463 - Steel Sheet Aluminum Coated by the Hot Dip Process
- F. NFPA 90A - National Fire Protection Association – Installation of Air Conditioning and Ventilation Systems

- G. NFPA 92A - Smoke-Control Systems
- H. SMACNA - Sheet Metal and Air Conditioning Contractors Association
- I. SMACNA HVAC Duct Construction Standards, Third Edition 2005, for Metal and Flexible Ducts
- J. U.L. - Underwriter's Laboratories
- K. UL 555 - Standard for Safety; Fire Dampers
- L. UL 555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems

1.5 SYSTEM DESCRIPTION

- A. Design static pressure:
 - 1. 1 inch w.g. minimum for all low pressure ductwork applications.

1.6 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 01.
 - 2. Submit product data indicating typical catalog of information including arrangements.
 - 3. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.
 - 4. Indicate mechanical and electrical service locations and requirements of equipment.
 - 5. Submit manufacturer's installation instructions.
- B. Shop Drawings:
 - 1. Submit 1/4" per foot shop drawing(s) showing all ducts, piping and equipment shown by plans and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural and electrical. Provide sections for all congested areas and mechanical rooms. Submit prior to construction of ductwork.

1.7 QUALITY ASSURANCE

- A. All equipment and materials shall be new and of the quality as specified herein. All work shall comply with the Local Building Code, Mechanical Code, Fire Code, and all other applicable State and Local Codes or ordinances.
- B. All equipment and materials shall be installed in a workmanlike manner by trained and experienced sheet metal technicians and mechanics as recommended by the manufacturers of the products installed.
- C. All ductwork to be manufactured in accordance with SMACNA standards.
- D. Where the standards and requirements of this specification exceed those of SMACNA, the requirements herein shall govern.
- E. Except where specified otherwise, all sheet metal used shall be constructed from prime galvanized steel sheets or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on 10 foot centers with manufacturer's name and gauge tolerances in inches.

- F. Spiral pipe:
 - 1. All pipe and fittings must be from a single manufacturer.
- G. Flexible:
 - 1. The composite assembly including insulation, vapor barrier, and glass scrim shall meet the Class 1 requirements of the latest NFPA Bulletin #90A and be labeled for a spread rating of 25 or less and a smoke development rating of 50 or under.

1.8 WARRANTY

- A. Warranty all ductwork and dampers for 1 year from the date of final acceptance. The warranty will cover workmanship, noise, chatter, whistling, and vibration. Ductwork must be free from pulsation under all conditions of operation.

PART 2 PRODUCTS

2.1 RECTANGULAR AND ROUND RIGID DUCTS:

- A. Material:
 - 1. New, prime grade sheet or coil steel
- B. Gauge:
 - 1. Select gauge in accordance with SMACNA Duct Construction Standards Tables 1-3 to 1-9 and Appendix- page 2.
- C. Auditorium and stages:
 - 1. Increase two gauges (heavier) for the first 20 feet of supply and return duct.
- D. Coating:
 - 1. Type:
 - a. Continuous, hot-dip, galvanized coating
- E. Application:
 - 1. 1-1/4 ounces per 1 square foot, two-sided sheet
 - 2. Comply with ASTM A 653.
- F. Identification:
 - 1. Sheet steel:
 - a. Stencil each sheet with manufacturer's name and gauge.
- G. Coil steel:
 - 1. Stencil coils on 10 foot centers with manufacturer's name and gauge.
- H. Construction:
 - 1. Manufacture in accordance with SMACNA Round Duct Standards, Tables 3-2A, 3-2B, and 3-3, Figures 3-1, 3-2, 3-3, 3-4, and 3-5.
 - 2. Pre-manufactured round duct may be used if approved by the Architect/Engineer.

2.2 ACCESS DOORS

- A. Install access doors to facilitate cleaning as required by code.
- B. Install access doors as required for access to fire protection devices.

2.3 EXHAUST DUCTS FOR FUME HOODS IN SCIENCE LABS

- A. Materials:
 - 1. Gauge in accordance with SMACNA standards.
 - 2. Stainless steel - welded

2.4 FLEXIBLE DUCTS

- A. Material: In accordance with SMACNA Metal and Flexible Duct Standards, Latest Edition.
- B. Construction:
 - 1. Factory insulate with high density fiberglass to a minimum R value of 5.79.
 - 2. Provide a positive interior air seal permanently bonded to a carbon steel spring helix.
 - 3. Sheath seal in a Class 1 vapor barrier and factory seal at both ends.
 - 4. Conform to U.L. 181, NFPA 90A
- C. Manufacturer/Model:
 - 1. ATCO 30 Series

2.5 VOLUME CONTROL DAMPERS

- A. Manufacturer: Nailor Industries Series 1020, 1021 or equal.
- B. Type:
 - 1. Manually operated single blade or multi-blade
 - 2. Conform to SMACNA Duct Standards (Metal & Flexible), Figures 2-12 & 2-13.
- C. Application:
 - 1. Provide in all branches, splits and taps whether indicated on plans or not.
- D. Construction:
 - 1. Provide an indicating device with lock to hold damper in proper position.
 - 2. All manual dampers installed above hard ceilings or at other inaccessible areas shall be supplied with a cable operated damper equal to Young Regulator Model 830A-CC. Damper(s) to be opposed blade type constructed of .050 minimum heavy duty extruded aluminum frames and blades. All necessary hardware to ensure compatibility with remote cable control system shall be included. Damper blades to include individual blade bushings for smooth and quiet operation. Damper blades shall rotate between a matched pair of formed and punched 306 stainless steel connecting slide rails which facilitate smooth blade movement and ensure alignment.

2.6 TURNING VANES

- A. Provide on all rectangular elbows except for return air jumper ducts noted on plans.
- B. Conform to SMACNA Duct Standards, Figures 2-3 and 2-4.

2.7 DUCT SEALANT

- A. Equal to Glenkote "Seal-Flex" duct sealer, Hardcast "Irongrip 601", Foster 32-19" or "Childers CP-146"

2.8 FIRE DAMPERS

- A. Manufacturer/Model:
 - 1. Fire Dampers – Pottorff, Ruskin, Greenheck, National Controlled Air or Nailor

2. Ceiling Fire Dampers/Thermal Blankets - CK-2000-1 thermal blanket and Model CFSR-2 ceiling damper for supply outlets (round or square) and CFSR-2 for return outlets (square).
- B. Type:
1. 212°F fusible link fire damper.
 2. Fire protection rating: 1.5 hours
 3. Conform to UL Standard 555 and be UL labeled
 4. Tested in accordance with AMCA 500.
- C. Application:
1. Provide at locations shown on plans and where required by Local and State ordinances.
- D. Features:
1. Maximum leakage 8 cfm at 4-inch S.P.
 2. Vertical or horizontal installation
 3. Interface with fire alarm
 4. Radiation blanket
 5. Blades 16 gauge galvanized, maximum 6-inch width.
 6. 5 year warranty.
- E. Manufacturer/Model:
1. Ceiling Fire Dampers:
 - a. Pottorff Ceiling Fire Dampers/Thermal Blankets – Series CFD
 - b. Equals by Nailor Industries, NCA, United Air, Ruskin, Greenheck

2.9 FIRE SAFETY FUNCTIONS - DUCT MOUNTED SMOKE DETECTORS, CONTROL RELAYS, AND SMOKE FIRE DAMPER CONTROL

- A. The Fire Alarm Contractor shall provide the Duct Mounted Smoke Detectors, Control Modules, Power Relays, and Control Relay devices and perform the final low-voltage hook-up to the fire alarm system.
- B. Duct mounted smoke detector housings and sample tubes shall be furnished by the Fire Alarm Contractor and mounted by the Mechanical Contractor.
- C. Line voltage hook-up shall be by the Electrical Contractor.
- D. Fire Alarm Safety Control Functions, which may include the operation of fire alarm Control Relays [CR] associated with duct mounted smoke detector [D]/air handler shut down, high volume low speed (HVLS) fan shut down, fire door hold-back and release, smoke fire damper motor control, et cetera, shall be initiated via Control Relays which shall be de-energized under fire alarm conditions. These Control Relays shall be provided and mounted by the Fire Alarm Contractor and located within three feet of the unit. These Control Relays shall be controlled by a fail-safe Fire Safety Control Function circuit. For each controlled device the contractor providing the device shall wire it internally for fail-safe shut-down and provide a labeled 3' coil of cable outside the unit to allow the fire alarm contractor to make final connection to the Common and N.O. or N.C. dry contacts on the fire alarm SPDT Control Relay. Each Fire Safety Control Function circuit controlled device shall be configured such that when the fire alarm system safety control circuit is re-energized, by the fire alarm control panel, the device shall return to normal operation (e.g. be ready to re-start) without a need for manual or environmental control system intervention.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Erect all ductwork in the general locations shown.
- B. Conform to all structural and finish conditions of the building.
- C. Ductwork shall not be allowed to pass through or over designated electrical rooms.
- D. Before fabricating any ductwork, check the physical conditions at the job site and make all necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.
- E. Where ductwork is shown to be lined on the inside with duct liner, the sizes shown on the plans are the inside dimensions. Therefore, sheet metal dimensions shall be increased accordingly.
- F. Seal all joints both transverse and longitudinal seams, with duct sealant in accordance to Table 1-2 Class B.
- G. Install 1" roll type filter media on all return duct openings prior to starting blowers. Leave in place and change as necessary during construction.
- H. Before installing grilles, operate air conditioning unit fans and remove all debris or foreign matter.
- I. Rectangular ductwork:
 - 1. Construct in accordance with SMACNA, Duct Construction Standards for the specific duct pressure classification involved (see pressure classification). Do not use radius ells with square throats.
- J. Round ductwork:
 - 1. Connect with slip type joints using a minimum of three sheet metal screws per joint and in accordance with SMACNA Duct Construction Standards.
- K. Flexible ductwork:
 - 1. All flexible ducts shall be demountable and individual lengths shall not be in excess of seven feet.
 - 2. Use only factory-made connectors.
 - 3. Flexible ducts should be installed fully extended, free of sags and kinks.
- L. Science Lab and Fume Hood Exhaust Ducts:
 - 1. Provide a liquid tight continuous external weld on all seams and joints in the ductwork.
 - 2. Provide access doors to duct and shaft.
- M. Reinforcement:
 - 1. Reinforce all ducts to prevent buckling, breathing, vibration, or unnecessary noise.
 - 2. Reinforcing shall be in accordance with SMACNA Duct Construction Standards (Metal and Flexible), Tables 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, and 1-9 plus any additional reinforcing to meet job conditions.
 - 3. All ducts shall be supported in accordance with SMACNA Duct Construction Standards (Metal and Flexible), Tables 4-1, 4-2, 4-3.
- N. Flexible Connections:
 - 1. Where ducts connect to fans or air handling units, make flexible airtight connections using "Ventglas" fabric.

2. The fabric must be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard.
 3. Provide a minimum of 1/2 inch slack in the connections, and a minimum of 2-1/2 inches distance between the edges of the ducts.
 4. Provide a minimum of 1 inch slack for each inch of static pressure on the fan system.
 5. Securely fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands.
 6. Do not install outdoors, except where detailed on plans.
 7. Where connections are made in outdoor locations, seal fabric to metal with mastic.
- O. Access Doors:
1. Install ductwork access doors in structural angle frames and provide with sash locks and hinges arranged for convenient access.
 2. Construct doors which occur in insulated ducts with an insulation filler.
 3. All access doors shall be appropriately labeled.
- P. Ducts passing through mezzanine walls:
1. Completely seal the penetration with acoustic sealant and fill all gaps between the ductwork and the wall materials.
 2. Sealant must be capable of preventing sound from exiting the mechanical rooms through these openings.
- Q. Ducts penetrating the floor of mezzanine mechanical areas:
1. Make the entire penetration watertight by installing appropriate flashing and/or application of G.E. silicone sealant.
 2. The penetration must be capable of maintaining standing water in the mechanical area without allowing any water through the opening.
- R. Duct Leakage:
1. Seal ductwork in accordance with Table 1-2 of the SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 2. Minimal leakage is expected for ductwork constructed to these standards but in no case shall the total leakage exceed 5% of designed CFM.
 3. All joints to be sealed with duct sealant.
- S. Fire and Smoke Dampers:
1. Install fire and smoke dampers at locations shown on plans, and where required by local and state ordinances.
 2. Do not compress or stretch SFD, FD frame into duct or opening.
 3. Install dampers square and free from racking with blade running horizontally.
 4. Handle damper using sleeve or frame. Do not lift damper using blades actuator, or jackshaft.
 5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
 6. Provide access doors in attached ductwork for inspection.
 7. Stencil each door "Fire Damper Access" per U. L. 555 standard.
 8. Install fire dampers in openings utilizing steel angles, sleeves, and other materials, and practices required to provide an installation equivalent that used by manufacturer when dampers were tested at UL.
 9. Install in accordance with damper manufacturer's published recommendations and instructions and NFPA Standard 90A.

3.2 BALANCING DAMPERS

- A. Volume Control Dampers:
 - 1. Install manually operated volume control dampers in all branch ducts, splits or taps whether indicated on the drawings or not. Install a minimum of 5'-0" from grille/diffuser.
 - 2. Provide indicating device with lock to hold damper in position.
- B. Cable Operated Dampers:
 - 1. Install a minimum of 5'-0" from grille/diffuser.
 - 2. Install to facilitate smooth blade movement and ensure alignment.
- C. Back Draft Dampers:
 - 1. Install back draft dampers as shown on plans.
 - 2. Manufacturer: Nailor Industries Series 1300 or equal.
- D. Air Intake Ducts:
 - 1. Insulate all outside air intake ducts.

3.3 DAMPER IDENTIFICATION

- A. Provide a securely attached red band and a label reading "Damper Location" at the location of all concealed manual dampers.
- B. All manual dampers which are not readily visible after duct insulation installation shall be identified in this manner.

3.4 DUCTWORK SUPPORT

- A. All ducting must be supported from building structure.
- B. Duct straps are not allowed to be screwed to roof decks, support from cross bridging or supported from bottom chord of joists.
- C. Do not support from roof or floor deck joist bridging.
- D. Support sizes and spacing shall conform to SMACNA Standards.

END OF SECTION

SECTION 23 33 33

ACCESS DOORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Access doors and their installation requirements.

1.3 RELATED SECTIONS

- A. Division 28 – Fire Alarm System
- B. Section 22 11 17 – Domestic Water Piping and Appurtenances
- C. Section 22 13 17 – Soil, Waste, and Sanitary Drain Piping, Vent Piping, and Appurtenances
- D. Section 22 13 18 – Condensate Piping
- E. Section 22 40 01 – Plumbing Fixtures and Fixture Carriers
- F. Section 22 66 54 – Chemical Waste and Vent Piping
- G. Section 23 00 00 – Basic Mechanical Requirements
- H. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- I. Section 23 09 13 – Programmable Control Devices for HVAC
- J. Section 23 31 13 – Metal Ductwork

1.4 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acudor
- B. Elmdor
- C. Mifab

2.2 ACCESS DOORS:

- A. Locations requiring access doors:
 - 1. Concealed valves
 - 2. Traps
 - 3. Trap primers
 - 4. Controls
 - 5. Cleanouts
 - 6. Dampers
 - 7. Ducts adjacent to fire doors, fire dampers, and smoke detectors.
 - 8. Equipment above hard ceilings.
 - 9. Other equipment requiring accessibility for operation and maintenance.
- B. Type:
 - 1. Hinged flush-type steel framed door with straps and exposed narrow border.
- C. Minimum size:
 - 1. 18" x 18" unless otherwise indicated.
 - 2. 24" x 24" for equipment above hard ceilings.
 - 3. Conform to architectural panel pattern for acoustical ceilings.
 - 4. Confirm size with Building Inspector and Engineer.
- D. Construction:
 - 1. Hinges: Concealed continuous type.
 - 2. Locking Device: Flush cam type, screw driver operated.
- E. Fire Rating:
 - 1. Same or better fire rating than the surrounding area.
- F. Access doors located in kitchens, restrooms or areas where water is present shall be stainless steel.

2.3 FACTORY PAINTING

- A. Apply prime coat of rust inhibiting paint, unless located in wet area.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. In suspended acoustical ceilings, provide a beaded pin or other approved means for identification and easy removal where necessary.
- C. Access doors shall only be installed in areas/locations that are readily accessible.
- D. Doors shall be installed in such a manner that door will open 180 degrees.

END OF SECTION

SECTION 23 34 16

HVAC FANS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Centrifugal fans

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
- C. Section 23 31 13 – Metal Ductwork
- D. Section 23 37 13 – Diffusers, Registers and Grilles

1.4 REFERENCES

- A. AMCA – Air Moving and Conditioning Association, Inc.
- B. UL – Underwriter's Laboratory

1.5 QUALITY ASSURANCE

- A. UL Listed and Bear Label
- B. Tested in accordance with AMCA standards

1.6 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.
- B. Submit product data indicating typical catalog data, including arrangements, dimensions, general assembly, and materials used in fabrication.
- C. Provide in table form a schedule similar to drawings with data listing all fans, information, accessories, etc.
- D. Indicate mechanical and electrical service locations and requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acme
- B. Cook
- C. Greenheck
- D. PennBarry
- E. Twin City Fans

2.2 GENERAL

- A. Provide fan type, arrangement, capacity, size, motor horsepower, and motor voltage as shown on the drawings.
- B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA) approved test codes and procedures. Seal to be attached.
- C. Supply fans with sound ratings below the maximums permitted by AMCA standards.
- D. All fans provided must bear the UL Label.
- E. Sound levels shall be as listed or quieter. Fans with excessive noise will be replaced at Contractor's expense.
- F. Fans are to be supplied with engraved aluminum nameplates indicating manufacturer, serial number, and model number.

2.3 CEILING MOUNTED EXHAUST FANS

- A. Type:
 - 1. Centrifugal direct driven in-line fans with galvanized steel fan wheels.
- B. Motors:
 - 1. Permanently lubricated with built-in thermal overloads.
 - 2. Mounting: Resilient mounts.
 - 3. Cooling: Forced air cooling.
- C. Construction:
 - 1. Hoods, housings & bases: galvanized steel, insulated, integral aluminum backdraft damper.
- D. Features:
 - 1. Disconnect switch: Internal wiring box with switch.
 - 2. Blower assembly to be easily removed without disconnecting the ductwork.
 - 3. Factory tested prior to shipment.
 - 4. Powder painted white steel grille.
 - 5. FACTORY INSTALLED VARIABLE SPEED CONTROLLER.
 - 6. Provide 277 volt to 120 volt transformer.

2.4 SUPPLEMENTAL EQUIPMENT

- A. Weatherproof motor covers for outdoor installations:
 - 1. Apply the same finish as used on the fan.

- B. Belt driven fans:
 - 1. Equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20 percent speed variation from full open to full closed.
- C. Nonadjustable motor sheaves:
 - 1. Use for motor sizes over 15 horsepower.
- D. Factory wired, safety disconnect switch on each unit.
- E. Heaters with starters.
- F. Internal overload protection circuit.

2.5 PROTECTIVE COATINGS

- A. Apply manufacturer's standard prime coat and finish to all fans, motors and accessories, except on aluminum surfaces or where special coatings are required.
- B. Galvanizing:
 - 1. Hot dip coat all surfaces which require galvanizing.
 - 2. Where galvanizing is specified, a zinc coating may be used.
 - 3. After fabrication, apply the zinc coating and air dry the coating to 95 percent pure zinc.
 - a. Zinc Coatings:
 - (1) Amercoat
 - (2) Diametcoat
 - (3) Sealube
 - (4) Zincilate
- C. All exhaust fans which will operate in a corrosive environment (Science Labs, etc.) shall have a factory applied acid resistant coating.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install fans according to the manufacturer's instructions and in the locations shown on the drawings.
- B. Verify compliance of "in Situ" vibration readings with AMCA Standard 204-05.
- C. All fans shall be air balanced in accordance with Section 23 05 93.

3.2 START-UP

- A. Start fans to verify rotation and operation sequence prior to test and balance.

3.3 IDENTIFICATION

- A. Provide identification per Section 23 05 53.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Grilles
- B. Diffusers
- C. Registers

1.3 RELATED SECTIONS

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- C. Section 23 31 13 – Metal Ductwork
- D. Section 23 34 16 – HVAC Fans

1.4 REFERENCES

- A. ARI Standard 890-94 Rating of Air Diffusers and Air Assemblies.

1.5 SUBMITTALS

- A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.
- B. Product data for review prior to placement of purchase order:
 - 1. Outlets
 - 2. Grilles
 - 3. Registers
 - 4. Control devices
 - 5. Diffusers
 - 6. Similar equipment
- C. Product data shall be submitted for each device specified. Data shall be arranged to match grille schedule.
- D. If a manufacturer other than the one scheduled on the plan is used, the sizes shown on the plans shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made.
- E. Selections shall meet the manufacturer's own published data for the above performance criteria.

- F. If grilles other than those scheduled by name are furnished, manufacturer shall be prepared to demonstrate compliance with noise criteria at Engineer's request and to Engineer's satisfaction.

1.6 COORDINATION

- A. Coordinate this work with work under Division 26 to insure that intended functions of lighting and air systems are achieved.
- B. Locations of outlets on plans are approximate and shall be coordinated with other trades to make symmetrical patterns.
- C. Locations shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan.
- D. The Contractor shall move any grille, register, or outlet up to four feet in any direction as directed by the Engineer at no additional cost.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide grilles, registers and diffusers as shown or scheduled on the plans. Conform to ARI 890-94.
- B. All air distribution devices in kitchen and any wet areas such as locker rooms, showers and restrooms shall be 100% aluminum construction.
- C. All air distribution devices for 1-hour structures (walls or ceilings) shall be steel construction conforming to all codes and standards.

2.2 MANUFACTURERS

- A. Metalaire
- B. Krueger
- C. Titus
- D. Nailor
- E. Carnes
- F. Price
- G. Tuttle & Bailey

2.3 PERFORMANCE CRITERIA

- A. Throw: Velocity at the end of the throw in the five foot occupancy zone will be between 25 to 50 FPM.

- B. Noise levels (NC Curve):
 - 1. Not to exceed those scheduled below.
 - a. Classrooms & Libraries - 25 N.C.
 - b. Cafeterias - 30 N.C.
 - c. Gymnasiums - 40 N.C.
- C. All devices shall be tested per Air Diffusion Council and labeled as such.

2.4 FINISHES

- A. Paint exposed devices with factory standard prime coat or factory finish coat. Architect/Engineer to determine final color of grille.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual dampers. These shall be the standard product of the manufacturer, subject to review by the Engineer.
- B. All ceiling devices shall be furnished to be compatible with the ceilings in which they are installed.

END OF SECTION

SECTION 23 81 26

SPLIT SYSTEM HVAC UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Split system HVAC units.

1.3 RELATED SECTIONS

- A. Section 22 13 18 – Condensate Piping
- B. Section 23 00 00 – Basic Mechanical Requirements
- C. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- D. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
- E. Section 23 09 13 – Programmable Control Devices for HVAC
- F. Section 23 23 00 – Refrigerant Piping
- G. Section 23 31 13 – Metal Ductwork

1.4 REFERENCES

- A. Refer to Section 23 00 00 for complete names of references identified in this section.

AGA	American Gas Association
AHRI 210/240	Unitary Air-Conditioning and Air Source Heat Pump Equipment
AHRI 270	Sound Rating of Outdoor Unitary Equipment
ANSI/ASHRAE 15	Safety Code of Mechanical Refrigeration
ASHRAE90.01-2001	Energy Standard for Buildings Except Low Rise Residential Buildings
ASHRAE 62-2001	Ventilation for Acceptable Indoor Air Quality
D.O.E.	Department of Energy
IECC	International Energy Conservation Code
NFPA 70 N.E.C.	National Electrical Code
UL	Underwriters Laboratory

1.5 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
- B. Submittals shall include:
 - 1. Unit model number
 - 2. Refrigerant type
 - 3. Sound rating in accordance with AHRI 270
 - 4. Cooling efficiency in accordance with AHRI Standard 210

- 5. All accessories
- C. Submit product data indicating typical catalog of information including arrangements.
- D. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.
- E. Provide in table form a schedule similar to drawings with data listing all unit information, data, accessories, etc.
- F. Indicate mechanical and electrical service locations and requirements.
- G. Submit letter from air conditioning manufacturer stating refrigerant line design has been reviewed.
- H. Submit manufacturer's installation instructions.
- I. Shop Drawings: (adjust as required)
 - 1. Submit 1/4" per foot shop drawing(s) showing all piping, ductwork, and equipment shown by drawings and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural, and electrical, and fire sprinkler drawings.

1.6 QUALITY ASSURANCE

- A. UL listed and must display UL label on all units.
- B. All units must comply with ASHRAE Standard 90.1 and the applicable International Energy Conservation Code.
- C. Unit performance data must be rated in accordance with AHRI Standard 210/240, and must display the AHRI symbol on all standard units.
- D. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.
- E. Air conditioning manufacturer to visit site and inspect installation of units and refrigerant lines, and provide letter stating installation conforms to installation instructions.
- F. Tested in accordance with the Department of Energy.
- G. The air conditioning equipment manufacturer shall be solely responsible for their equipment that does not comply with the performance of their published catalogues and specifications.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
 - 1. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.
- B. Air conditioning manufacturer to visit site and inspect installation of units and refrigerant lines, and provide letter stating installation conforms to installation instructions.

1.8 WARRANTY

- A. Complete 1 year warranty on all equipment.

- B. Additional 4 year warranty provided for the compressors and heat exchangers.
- C. Additional 9-year warranty provided for galvanized heat exchangers.
- D. Additional 14-year warranty provided for stainless steel heat exchangers.
- E. The warranted compressor assembly consists of the starter, rotor, eccentric shaft, eccentric rods, pistons, wrist pins, suction valves, discharge valves, unloading mechanisms, oil pump, and the housing in which these parts are enclosed.
- F. The warranty shall indicate model, serial number of the unit and commencing date. The commencing date of the warranty shall be after the building has been accepted for occupancy.

PART 2 PRODUCTS

2.1 MANUFACTURERS: HEAT PUMP

- A. 3 to 5 tons – 17.0 SEER
 - 1. Lennox
 - 2. Trane
 - 3. Units to have two stage compressor and a minimum two speed fan.

2.2 SPLIT SYSTEM HEATING/ COOLING UNITS

- A. Minimum Cooling Efficiencies:
 - 1. EER ratings by AHRI Standard 210/ 240 and AHRI Standard 340/360:
 - a. All units to comply with ASHRAE 90.1.
 - b. All units to comply with International Energy Conservation Code 2015.
- B. Heat Pump Units
 - 1. Features:
 - a. Crankcase heaters
 - b. Timed off control
 - c. Low Ambient cooling to 45°F
 - d. Hi/Low pressure switches
 - e. Over current protection
 - f. Filter Dryer
 - g. Provide hail guards on all condensing units.
 - h. Factory installed defrost control to operate on demand
 - i. Provide any reference specialties that manufacturer requires
 - j. Refrigerant R-410A
- C. Condensing Units:
 - 1. Features:
 - a. Crankcase heaters
 - b. Timed off control
 - c. Low Ambient cooling to 45°F
 - d. Hi/Low pressure switches
 - e. Over current protection
 - f. Filter Dryer
 - g. Provide Hail Guards on all Condensing Units
 - h. Provide any reference specialties that manufacturer requires
 - i. Refrigerant 410-A

- D. All Air Handlers:
1. Features:
 - a. 2 inch filter racks to be provided at each air handler.
 - b. Easy access to filters
 - c. Provide extra set of filters, Farr 3030 pleated 2" thick. MERV $\geq$ 6.0.
 - d. Low voltage terminal strip
 - e. All blowers shall deliver a minimum of 450 cfm/ton at .5" E.S.P.
 - f. Furnish and install auxiliary drain pans below each air handler. Provide float switches for all auxiliary drain pans.
 2. **Class I motorized outside air dampers. All outside air dampers to be low leak dampers. Dampers shall have an air leakage rate not greater than 4 CFM/ sqft. and shall be labeled by an approved agency when tested in accordance with AMCA 500D.**
- E. Accessories:
1. 2-Stage Compressor Unit:
 - a. All split system units with two stage compressors are to have a minimum of two fan speeds. In first stage cooling, the compressor is to be in first stage, and the fan is to be set to low speed. In second stage cooling, the compressor is to be in second stage, and the fan is to be set to high speed. Set differential temperature between first stage cooling and second stage cooling at 2°F (adj.).
 2. Unit with CO2 Sensor (Demand Controlled Ventilation):
 - a. Motorized, modulating outside air dampers are to be installed in outside air ductwork that connects to the return air ductwork. Dampers are to be spring closed in the unoccupied mode. CO2 sensor will provide demand control ventilation by keeping the damper in minimum position unless differential between outside CO2 levels and inside CO2 levels are greater than 700 ppm (adj.). An example if outside air CO2 level is 500 ppm, and the indoor CO2 sensor reads 1100 ppm, the damper is to modulate open to minimum position and be fully opened at 1190 ppm. All outside air is to be filtered.
 3. Unit with Economizer Module and Fault Detection and Diagnostics.
 - a. All cooling only units are to be provided with a dry bulb economizer. When outdoor dry bulb conditions are met, and the space temperature sensor is calling for cooling, the economizer mode of the unit shall provide free cooling to the space.
 - b. All units 3 tons and above are to be provided with a dry bulb economizer. When outdoor dry bulb conditions are met, and the temperature sensor is calling for cooling, the economizer shall provide free cooling to the space. The dehumidification cycle and heating modes shall be disabled during economizer mode.
 - c. All units 10 tons and above are to be provided with a dry bulb economizer and a power exhaust fan. The powered exhaust fan shall only be enabled during economizer mode.
 - d. All economizers must be equipped with fault detection and diagnostics. The unit shall be capable of reporting faults to a fault management application system or displayed on the zones thermostat. The fault detection system shall be capable of detecting the following faults:
 - (1) Air temperature sensor failure.
 - (2) Not economizing when the unit should be economizing.
 - (3) Economizing when the unit should not be economizing.
 - (4) Dampers not modulating.
 - (5) Excess outdoor air.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with the plans, manufacturer's instructions and approved shop drawings.
- B. Contractor to provide and install thermostat wire from air handler to condensing units.
- C. Contractor to provide and install flexible watertight conduit for wiring.
- D. Coordinate with plumbing contractor on all condensate piping.
- E. Install roll type filter media over all return air openings during construction if unit is operated. Replace as required.
- F. Accessories:
 - 1. Unit with CO2 Sensor (Demand Controlled Ventilation):
 - a. Motorized, modulating outside damper to open to minimum position when fan is ON, and spring return close when fan is OFF. All dampers are to modulate with call from CO2 sensors. All outside air to be filtered.

3.2 IDENTIFICATION

- A. Provide identification per Section 23 05 53.

3.3 EQUIPMENT START UP

- A. Equipment manufacturer to provide start-up.
- B. Install and make hook-up to float switches.
- C. Measure:
 - 1. Outside air temperature, entering and leaving conditions of evaporators and condensers, compressor amps, indoor blower amps, gas pressure, pressure drop across evaporator coil.
 - 2. Operate all units in heating and cooling modes with outside air in operation.
 - 3. Provide report with final request for payment.
 - 4. Install new, clean filters prior to test and balance.
 - 5. Provide connection to refrigeration piping system and evaporators.

3.4 SINGLE ZONE HEAT PUMP SPLIT SYSTEM WITH 2 STAGE COMPRESSOR AND CO2 CONTROL

- A. GENERAL:
 - 1. Each unit shall be provided with a cooling section, heating section, supply fan section, and a microprocessor control board. The mechanical contractor shall provide an outside air/ return air damper section, and a 0-100% motorized, modulating outside air damper with spring return. The mechanical contractor shall install the damper section. The space temperature sensor shall be provided with a local override button. The mechanical contractor shall provide a dedicated stand-alone programmable thermostat for each unit. The occupied/unoccupied mode of operation shall be defined by the programmable thermostat optimum start/stop schedule.
- B. FAN CONTROL:
 - 1. Fan speed shall be controlled by the air handler, based on its internal controls. The fan shall run in low speed during first stage cooling and high speed during second stage cooling.

C. OUTSIDE AIR CONTROL:

1. During unoccupied operation, the motorized, modulating outside air damper shall be fully closed.
2. During occupied operation, the motorized, modulating outside air damper shall be closed when the outside air temperature is below 20°F (adj.).
3. During occupied operation, the outside air damper shall be set to its minimum position (reference scheduled CFM). The programmable thermostat shall monitor the CO2 level in the space and verify the level of CO2 is below setpoint of 1100 ppm. Upon a rise in CO2 above setpoint of 1100 ppm, the outside air damper shall modulate open from the minimum position to return the CO2 level below 1100 ppm. A linear progression shall be set so that at a CO2 level of 1190 ppm, the outside air damper shall modulate open to the maximum set position (e.g. maximum scheduled value of outside air CFM). An algorithm shall be set so that the outside air CFM follows a linear trend between maximum and minimum CFM for values between 1100 ppm and 1190 ppm. The outside air damper shall never open more than the schedule maximum outside air for the respective mode. Once the CO2 value falls below setpoint of 1100 ppm, the outside air damper shall modulate to its minimum position.

D. TEMPERATURE CONTROL:

1. Warm-up: The programmable thermostat shall determine the required warm-up period based on the optimized start algorithm. In this mode, the outside air damper shall be fully closed and the programmable thermostat will control the unit to reach occupied heating setpoint of 70°F (adjustable). Once the occupied heating setpoint temperature has been reached, the programmable thermostat shall switch the unit to the occupied mode.
2. Cool-down: The programmable thermostat shall determine the required cool-down period based on the optimized start algorithm. In this mode, the outside air damper shall be fully closed and the programmable thermostat will control the unit to reach occupied cooling setpoint temperature of 74°F (adjustable). Once the occupied cooling setpoint temperature has been reached, the programmable thermostat shall switch the unit to the occupied mode.
3. Unoccupied Mode: In the unoccupied mode of operation, the unit outside air damper shall be fully closed and the supply fan shall cycle with the unit's heating and cooling modes. The programmable thermostat shall enable the heating or cooling as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 82°F cooling) as sensed by the space temperature sensor. Upon a rise in space temperature above the unoccupied cooling setpoint, the programmable thermostat shall enable the mechanical cooling. On a drop in space temperature below the unoccupied heating setpoint, the programmable thermostat shall enable the heating. First stage of heating shall be to activate the reversing valve and operate in heat pump mode. Upon a further drop in space temperature, the electric heat shall be energized.
4. The space temperature sensor shall have an override pushbutton. Whenever the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.
5. Occupied Mode: In the occupied mode of operation, the unit supply fan shall cycle with a call for heating or cooling. The programmable thermostat shall energize the heating and cooling as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor with digital display and pushbutton override. Space set point shall be user adjustable within ±2°F (adj.). On a rise in space temperature above the occupied cooling setpoint, the programmable thermostat shall energize the first stage of mechanical cooling. Upon a further rise in space temperature of 2°F (adj.) above the occupied cooling setpoint, the programmable thermostat shall energize the second stage of mechanical cooling. On a drop in space temperature below the occupied cooling setpoint, the reverse shall occur. On a further drop in space temperature below the occupied heating setpoint, the programmable thermostat shall operate the reversing valve and operate in heat pump mode. Upon a

further drop in space temperature below the occupied heating setpoint, the programmable thermostat shall energize the electric heat. On a rise in space temperature above the heating setpoint, the reverse shall occur.

6. Economizer Mode: In unoccupied or occupied mode, anytime there is a call for cooling in the space, and the outside air temperature is 55°F (adj.) or below, the motorized, modulating outside air damper is to open to the economizer outside air position (Reference scheduled CFM), and provide free cooling to the space. During economizer mode, the compressor is to remain off and the air handler fan is to operate in low speed.

END OF SECTION

SECTION 23 81 27

SMALL CAPACITY SPLIT SYSTEM UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Split system cooling units for elevator machine rooms, electrical rooms, MDF and IDF Rooms as noted in schedule and shown on drawings.

1.3 RELATED SECTIONS

- A. Section 22 13 18 – Condensate Piping
- B. Section 23 00 00 – Basic Mechanical Requirements
- C. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- D. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
- E. Section 23 09 13 – Programmable Control Devices for HVAC
- F. Section 23 23 00 – Refrigerant Piping
- G. Section 23 31 13 – Metal Ductwork

1.4 REFERENCES

- A. Refer to Section 23 00 00 for complete names of references identified in this section.
- B. ARI 210/240 - Unitary Air-Conditioning and Air Source Heat Pump Equipment
- C. ARI 270 - Sound Rating of Outdoor Equipment
- D. ARI 270 - Sound Rating of Outdoor Unitary Equipment
- E. ANSI/ASHRAE 15 - Safety Code of Mechanical Refrigeration

1.5 SUBMITTALS

- A. Product Data:
 - 1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
 - 2. Submittals shall include:
 - a. Unit model number
 - b. Refrigerant type
 - c. Sound rating in accordance with ARI 270
 - d. Cooling efficiency in accordance with ARI Standard 210
 - e. All accessories

3. Submit product data indicating typical catalog of information including arrangements.
 4. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.
 5. Indicate mechanical and electrical service locations and requirements.
 6. Submit manufacturer's refrigerant piping.
 7. Submit manufacturer's installation instructions.
- B. Shop Drawings: (adjust as required)
1. Submit 1/4" per foot shop drawing(s) showing all piping and equipment shown by drawings and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural, and electrical, and fire sprinkler drawings.

1.6 QUALITY ASSURANCE

- A. UL listed and must display UL label on all units.
- B. Unit performance data must be rated in accordance with ARI Standard 210/240, and must display the ARI symbol on all standard units.
- C. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.
- D. Manufacturer to size refrigerant lines.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.

1.8 WARRANTY

- A. Complete 1 year warranty on all equipment
- B. Additional 5 year warranty provided for the compressors and heat exchangers.
- C. The warranted compressor assembly consists of the starter, rotor, eccentric shaft, eccentric rods, pistons, wrist pins, suction valves, discharge valves, unloading mechanisms, oil pump, and the housing in which these parts are enclosed.
- D. The warranty shall indicate model, serial number of the unit and commencing date. The commencing date of the warranty shall be after the building has been accepted for occupancy.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Daikin
- B. Mitsubishi
- C. LG
- D. Trane

- E. Carrier

2.2 CONDENSING UNITS

- A. Features:
 - 1. Crankcase heaters
 - 2. Timed off control
 - 3. Low Ambient to 50°F
 - 4. Hi/Low pressure switches
 - 5. Over current protection
 - 6. Filter Dryer

2.3 CONTROLS

- A. Controller Features:
 - 1. Manually activated “dry” mode. Low speed indoor fan, high speed compressor.
 - 2. Temperature Settings/Display
 - 3. 24 Hour Timer
 - 4. Fan Speed Indicator
 - 5. Mode Settings (auto, cool/dry)
 - 6. EMCS Gateway via RS-232 Terminal

2.4 ALL AIR HANDLERS

- A. Features:
 - 1. Easy access to filters
 - 2. Low voltage terminal strip
 - 3. All blowers shall deliver a minimum of 450 cfm/ton at .5" E.S.P.
 - 4. Filter racks to be provided in each air handler.
 - 5. Condensate pump

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with the plans, manufacturer's instructions and approved shop drawings.
- B. Both suction and liquid lines are to be insulated.

3.2 IDENTIFICATION

- A. Provide identification per Section 23 05 53.

3.3 EQUIPMENT START UP

- A. Provide start-up.
 - 1. Start-up Data and Report:
 - a. Follow all manufacturers' directions.
- B. Measure:
 - 1. Outside air temperature, entering and leaving conditions of evaporators and condensers, compressor amps, indoor blower amps, gas pressure, pressure drop across evaporator coil.
 - a. Operate all units in cooling modes.

- b. Provide report with final request for payment.
- c. Install new, clean filters. Cover return air with filter media until construction is complete.
- d. Provide connection to refrigeration piping system and evaporators.
- e. Do not install condensate pumps over any equipment panels.
- f. Condensate pumps are to operate any time the unit is in the cooling mode and water is in drain pan. Follow manufacturer's instructions.

END OF SECTION

SECTION 26 00 00

ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Bidding requirements, contract forms, conditions of the contract, Division 1 - General Requirements apply to work of this division.

1.2 SECTION INCLUDES

- A. Furnishing of all materials, equipment, tools, scaffolding, labor and transportation required for the complete installation of the electrical systems as shown on the drawings and as specified herein.
- B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Architectural, Structural, Plumbing, Heating, Ventilating, Air Conditioning and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.
- C. It is the intent of these specifications to provide complete installations even though each and every item necessary is not specifically mentioned or shown. In general, the work specified in this section shall consist of, but is not limited to, the following:
 - 1. Electrical demolition.
 - 2. Systems of raceways, conductors, cables, boxes, receptacles, wiring devices, and cover plates.
 - 3. Relays, wiring, devices, contactors, conduit and other required equipment for all systems and details shown on the electrical drawings.
 - 4. Electrical identification.
 - 5. Surge Protective Devices (SPDs)
 - 6. Utility services, utility requirements, including conduit and coordination.
 - 7. Switchgear including switchboards and panelboards.
 - 8. Secondary electrical service and distribution system including wiring.
 - 9. Lighting fixtures, lamps and ballasts.
 - 10. Coordination and final connection to all line voltage systems or equipment provided under other divisions.
 - 11. Testing of wire and cable installation.
 - 12. Submittals and shop drawings.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Control wiring of HVAC and related equipment as specified in other sections.
- B. Motor starters required on HVAC and related equipment as specified in other divisions and sections.

1.4 CODES, STANDARDS AND THEIR ABBREVIATIONS

- A. Perform all Division 26 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.
- B. In addition to the requirements outlined in other sections of the specifications the following standards are imposed as applicable to the work in each instance:
 - 1. NECA standards for installation.
 - 2. NFPA No. 70, National Electric Code.
 - 3. Local Codes and Ordinances.
 - 4. COG Standard Specifications for Public Works Construction.
 - 5. Title 25, Health Services, Part 2, Texas Department of Health, Chapter 145, Long Term Care Subchapter Q.
 - 6. OSHA Standard 2207 – Construction Industry Standard
 - 7. OSHA 29 CFR 1926 - Regulation of Excavation
 - 8. Texas Underground Facility Damage Prevention Act (H.B. 2295)
- C. Where local codes or practices exceed or conflict with the NEC, it shall be the Contractor's responsibility to perform the work in accordance with the local code prevailing and local interpretations thereof. Any such additional work shall be performed at no additional cost to the Owner.
- D. Materials and components shall be UL listed and approved for the purpose intended.
- E. The Contractor shall obtain all permits required to commence work and, upon completion of the Work, obtain and deliver to the Owner's Representative a Certificate of Inspection and Approval from the State Board of Fire Underwriters, the City of Jarrell, Texas and other authority having jurisdiction. The Contractor shall pay required permit fees.

1.5 LIST OF ASSOCIATIONS AND STANDARDS

- A. The following abbreviations are applicable for this entire division.
 - 1. ANSI - American National Standards Institute, 1430 Broadway; New York, NY 10018.
 - 2. ASTM - American Society for Testing and Materials, 1916 Race Street; Philadelphia, PA 19103.
 - 3. CBM - Certified Ballast Manufacturers Association, 2116 Keith Building; Cleveland, Ohio 44115.
 - 4. IEEE - Institute of Electrical and Electronics Engineers, 345 East 47th Street; New York, NY 10017.
 - 5. ICEA - Insulated Cable Engineers Association, P.O. Box P; South Yarmouth, MA 02664.
 - 6. NEC - National Electrical Code; NFPA No. 70.
 - 7. NECA - National Electrical Contractors Association, Inc., 7315 Wisconsin Ave.; Washington, DC 20014.
 - 8. NEMA - National Electrical Manufacturers Association, 155 East 44th Street; New York, NY 10017.
 - 9. NESC - National Electrical Safety Code, ANSI 2.
 - 10. NFPA - National Fire Protection Association, 60 Batterymarch Street; Boston, MA 02110.
 - 11. OSHA - Occupational Safety and Health Administration, US Department of Labor; Washington, DC 20402.
 - 12. UL - Underwriters Laboratories, Inc., 333 Pfingsten Road; Northbrook, IL 60062.
- B. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.

- C. The date of the code or standard is that in effect on the date of issue of the contract documents except when a particular publication date is specified.
- D. This Contractor shall comply with all State, Federal, NFPA, local codes and ordinances that may alter any part of the plans or specifications. This Contractor shall bear all costs for correcting any deficiencies due to non-compliance.
- E. Where local codes and ordinances are not in writing or on record but a local precedence has been set, the Owner shall pay for any additional resulting cost.

1.6 DEFINITIONS

- A. Approval: It is understood that approval must be obtained from the Architect in writing before proceeding with the proposed work. Approval by the Architect of any changes, submitted by the Contractor, will be considered as general only to aid the Contractor in expediting his work.
- B. Directed: Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.
- C. Furnish: The term furnish means to equip with what is needed, supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- D. Install: The term install describes operations at the Project site including setting in position, connecting on adjusting for use, the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- E. Provide: Defined as requiring the furnishing, supplying, to make available, and installation of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.
- F. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.

1.7 ABBREVIATIONS FOR ELECTRICAL DRAWINGS

A	Amperes
ALT	Alternate
AFF	Above finish floor
AFG	Above finished grade
AWG	American wire gauge
ATS	Automatic transfer switch
CLG	Ceiling
CKT	Circuit
CCTV	Closed circuit television
DFA	Down from above
DISC	Disconnect
EWC	Electric water cooler
EXIST	Existing
FAP	Fire alarm plan
FACP	Fire alarm control panel
FAGA	Fire alarm graphic annunciator
FARA	Fire alarm remote annunciator

FPC	Fire protection contractor
GRN	Ground
GFCI	Ground-fault circuit interrupters
GFP	Ground-fault protection
HP	Horsepower
HPS	High pressure sodium
KW	Kilowatts
KES	Kitchen equipment supplier
MTS	Manual transfer switch
MH	Metal Halide
MCC	Motor control center
NC	Normally closed
NO	Normally open
NTS	Not to scale
NIC	Not in contract
PNL	Panel
SFD	Smoke/Fire Damper
SU	Stub up above finish floor
SWBD	Switchboard
TV	Television
TX	Transformer
TYP	Typical

1.8 NEMA CLASSIFICATIONS

- A. For complete definitions and listing see NEMA Standards.
 - Type 1 General Purpose, Indoor.
 - Type 2 Drip-proof, Non corrosive, Indoor.
 - Type 3R Rain proof, Outdoor.
 - Type 4 Watertight and dust tight, Non corrosive. Indoor and outdoor.
 - Type 4X Watertight and dust tight, Corrosion resistant. Indoor and outdoor.
 - Type 12 Dust tight, Drip-tight, Non corrosive, Indoor. See NEC 2008 110.22 FPN.

1.9 PROJECT/SITE CONDITIONS

- A. Before submitting a proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required, including all required utilities.
- B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.10 SUBMITTALS

- A. Refer to Section 26 00 90, Electrical Submittal Procedures.

1.11 QUALITY ASSURANCE

- A. Provide complete installations of and verify that all systems, comply with NFPA 70, latest edition. The more stringent of the N.E.C. or specifications shall apply to this project.

- B. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.
- C. Submit a bid on the basis of a complete installation including all labor, material, delivery, insurance, permits, inspection fees and tests required even though each and every item necessary is not specifically mentioned or shown.
- D. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern. In case of any conflict between the specifications and plans, the Engineer shall make the final decision. Refer to Division 1 - General Requirements.

1.12 CONTRACTOR'S RESPONSIBILITY

- A. Erect barricades, protective fencing, and signs as required to prevent injury to personnel on site.
- B. Coordinate all utility services and/or revisions with utility companies for base bid.
- C. Make permanent connection to new utilities or existing lines. Determine depth and location, and bid accordingly. Relocate and repair any existing lines cut by general construction work.
- D. Plans do not show exact location and elevations of lines. Deviate from plans as required to conform to the general construction, provide proper grading and installation.
- E. Maintain all utility services during construction to existing portions of job that remain.
- F. Procure and pay for all necessary permits or licenses to carry out the work. Pay all costs in connection with metering.
- G. Obtain and pay for all the necessary certificates of approval which must be delivered to the Architect before final acceptance of the work.
- H. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.
- I. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.
- J. Exposed piping and/or other materials will not be permitted in the finished job except where noted on the drawings.
- K. Provide required hook-up to line voltage at all electromagnetic door holder/release, fire/smoke dampers, and smoke dampers. Provide required relays and wiring to fire alarm panels and coordinate with other specified work.
- L. Accomplish all demolition and remodeling work involving this trade in a manner and completeness to provide the appearance of new construction work.
- M. Replace any usable equipment and/or structure damaged during demolition and remodel work.

1.13 SUBSTITUTION OF PRODUCTS

- A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate

technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.

- B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.
- C. The Engineer will consider all such submittals and the Architect will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.
- D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.
- E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.
- F. Items noted as "No Substitutes" shall be as specified only.
- G. Samples shall be provided by the manufacturer of the proposed substitute unit for evaluation when required at no charge and non-returnable.
- H. Requests for substitution are understood to mean that the Contractor:
 - 1. Has personally investigated the proposed substitution and determined that it is equivalent or superior in all respects to that specified.
 - 2. Will provide the same guarantee for the substitution that he would for that specified.
 - 3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.
- I. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances.
 - 1. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
 - 2. The specified product is unavailable through no fault of the Contractor.
 - 3. The manufacturer refuses to warranty the specified products as required.
 - 4. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
 - 5. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.
- J. Revisions to the electrical system caused by substitutions shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.14 PROJECT RECORD DOCUMENTS

- A. This Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and existing switchgear, devices, fixtures, equipment and new or existing site utilities and lights.
- B. Upon submitting his request for final payment, he shall turn over to the Architect, record document submittals as outlined in Division 1 - General Requirements of the Specifications.

- C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication. Two (2) each prepared in a three inch (3"), 3-ring binder, neat in appearance of sufficient size and turned over to the Architect for checking and subsequent delivery to the Owner:
 - 1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
 - 2. All shop drawings.
 - 3. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
 - 4. Any and all other data and/or plans required during construction.
 - 5. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.
- D. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
 - 1. General Contractor and all sub-contractors.
 - 2. Major Equipment Suppliers.
 - 3. Submit megger reading log copies in accordance with Section 26 08 11.
 - 4. Submit ground tests methods and results in accordance with Section 26 08 11 & 26 05 26.
 - 5. Submit testing of electrical system results in accordance with Section 26 08 11.
 - 6. Submit conductor insulation test results in accordance with Section 26 05 19.
 - 7. Submit SPD warranty in accordance with Section 26 43 00.
 - 8. Submit test data results for transformers in accordance with Section 26 22 13.

1.15 PLANS AND SPECIFICATIONS

- A. The intent of the drawings is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.
- B. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
- C. Install the work complete including minor details necessary to perform the function indicated. Provide an electrical system (including all hook ups) complete in every respect and ready to operate.
- D. If clarification is needed, consult the Engineer.
- E. Review pertinent drawings and adjust the work to conditions shown. Where discrepancies occur between drawings, specifications, and actual field conditions, immediately notify the Engineer for his interpretation.
- F. The Architect reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.
- G. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.16 ELECTRICAL WIRING AND EQUIPMENT FOR MECHANICAL SYSTEMS

- A. Electrical Contractor To Provide
 - 1. Line Voltage and hook-up to all plumbing equipment (Division 22), HVAC equipment (Division 23), and building automation equipment (Division 25), including required manual safety switches with fuses/heaters of required size.
 - 2. All conduit into accessible attic space for thermostats and sensors.

3. All lighting contactors, mechanically held with control relay, required coil voltage coordinated with controls contractor.
 4. Junction Boxes (Standard One or Two Gang) required for controls contractor, and coordination with controls contractor.
- B. Mechanical Contractor to Provide
1. All motor starters (with heaters as required).
 2. All thermostats.
 3. All HVAC Equipment.
 4. All relays, contactors, and switches required to start/stop Mechanical Equipment other than switches shown on and required by Division 26.
- C. Controls Contractor to Provide
1. All required relays associated with Controls in specifications.
 2. All sensors.
 3. All conduit required above ceiling.
 4. All control wiring.
- D. The Electrical plans are based on the equipment and devices scheduled shown on the drawings or as called for in the specifications. Should any mechanical equipment or device associated devices be changed or accepted from those which are shown or noted, all electrical and/or mechanical changes shall be made at the expense of the trade or contractor initiating the change with no expense to the Owner, Architect, Engineer or their representatives.
- E. All conduit and boxes for thermostats and/or sensors shall be provided by this contractor. A thermostat or sensor junction box and 1/2" conduit to accessible attic and/or to corridor shall be provided for each room served with HVAC equipment. Coordinate with Division 23 for exact locations and requirements.
- F. Details on Electrical drawings showing HVAC/Mechanical/Control Equipment providing of various relays devices, wiring and other equipment shall be provided by this Contractor as directed and as required per drawing.

1.17 UTILITIES, LOCATIONS, AND EXISTING CONDITIONS

- A. Location of power company electrical service poles, transformers, telephone service pedestal, cable television service, and any existing underground services, where shown, have been obtained from substantially reliable sources, are shown as a general guide only, without guarantees as to accuracy.
- B. The Contractor will examine the site, verify all requirements, service points, and availability of all services required to complete this project. No consideration will be granted for any alleged misunderstanding of the materials and labor to be provided as necessitated by nature of the site including those items which may be fairly implied as essential to the execution and completion of any and all parts of this project. All proposals shall take these existing conditions into consideration and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility. Verify location and check for existing underground utilities and lines before ditching.
- C. Coordinate all services with the Utility Companies during construction, coordinate changes made by utility companies to the design of the project, check for existing underground utilities and lines before ditching, be responsible for repair of any cut or damaged lines or utilities uncovered. Coordinate with the owner, architect and utility company the scheduling of any shut-downs or delays in providing service that may occur.

- D. The owner shall be responsible for all costs of the public utility companies' changes and/or unforeseen site utility repairs under the following circumstances except for negligence on part of the contractor:
 - 1. Public utility service requirements or changes which alter the scope of this project from original design and agreement/approach.
 - 2. Existing conditions which require that certain assumptions be made that could not be verified at the site.
 - 3. Changes/repairs during construction as a result of utility companies not conforming to their agreements, methods, locations, etc., established during design.
- E. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.

1.18 FINAL COMPLETION REQUIREMENTS

- A. The following will be required at time of final completion.
 - 1. Refer to general conditions.
 - 2. Final clean up completed.
 - 3. All systems are fully operational, all material and devices installed and tested.
 - 4. Ground tests (megger readings) performed, two copies of method used, and results attached.
 - 5. Project Record Documents submitted to the Architect.
 - 6. Spare material delivered to the Owner and documented.
 - 7. Owner instructions completed.

1.19 MANUFACTURER'S INSTRUCTIONS

- A. All equipment and devices shall be installed in accordance with the drawings and specifications, manufacturer's instructions and applicable codes.
- B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.20 INSTALLATION

- A. Cooperation with trades of adjacent, related or affected materials or operations, and or trades performing continuations of this work under subsequent contracts is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades, including under the general contractor Division 1, and Division 23.
- B. The Electrical Contractor shall coordinate installation of the electrical system with the General Contractor, Mechanical, Plumbing, and Communications Contractors to insure a complete working system for the Owner.
- C. Where required, all conduit and boxes for all systems, except mechanical controls specified otherwise, shall be provided by the Electrical Contractor. Any and all allowances shall be included.
- D. All wiring shall be enclosed in conduit or raceway in all exposed areas such as gymnasium, shops, stages, or field houses.

- E. Work must be performed by workmen skilled in their trade. The installation must be complete whether the work is concealed or exposed.
- F. The Contractor shall construct foundations for floor mounted equipment where indicated on the Drawings. Foundations generally shall be built up from structural floor slabs and shall be made of 3000 psi concrete four (4) inches thick unless otherwise indicated or specified. Top edges shall be beveled. All exposed surfaces shall be finished with cement mortar troweled smooth. Reinforcing shall be 6 x 6-10/10 welded wire mesh.
- G. Equipment shall be secured to foundations by this Contractor with anchor bolts embedded in the concrete of ample size and proper arrangements to suit equipment furnished.
- H. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings. Branch circuits shall not be installed in or under the slab, and will not be accepted unless shown or required on the drawings.
- I. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings. Review with the Architect any proposed changes in outlet or equipment location. Relocation of outlets before installation, of up to 3 feet from the position indicated, may be directed without additional cost. Remove and relocate outlets placed in an unsuitable location when so requested by the Architect.

1.21 TEMPORARY SERVICE AND LIGHTING

- A. Electrical service to all portions of existing buildings at the construction site not involved with the project shall remain in operation throughout construction. Provide all required temporary electrical service in the base bid to all required areas so as to satisfy OSHA requirements.
- B. All metering and temporary electrical service charges and/or costs of utilities shall be paid by The Contractor/Managing Construction Contractor.

1.22 ADDITIONAL MATERIALS:

- A. Include in the Base Bid:
 - 1. All costs to provide 20 additional communication outlet or signal locations, all required boxes, labor and conduit as directed by the Architect. Devices, plates, and wiring by Communications Contractor(s).
 - 2. All costs to provide one (1) additional electrical circuit as required for fire alarm system signal power expanders or fire safety control circuits including all required circuit breakers, wiring, conduit, labor and devices as specified and directed by Architect.
 - 3. All costs to provide 5 additional electrical circuits, all required circuit breakers, wiring, conduit, labor and devices as specified and directed by Architect. Each circuit to be priced with a rating of 20 amps and at a distance of 100 feet to furthestmost device. Each circuit to include (8) duplex receptacles.
 - 4. All costs to provide 2 additional lighting circuits, all required circuit breakers, wiring, conduit, labor and devices as specified and directed by Architect. Each circuit to be priced with a rating of 20 amps and at a distance of 100 feet to furthestmost device. Each circuit to include 15 light fixtures equal in value to fixture type "B".
 - 5. All costs to provide 10 additional exit fixtures equal in value to exits type 'X' as noted on drawings, all required wiring, conduit, labor and devices as specified and directed by the Architect. Wiring and conduit to be priced at a distance of 50 feet.
 - 6. All costs to provide 10 additional light fixtures with battery equal in value to fixture type "BE".
 - 7. All costs to provide 10 additional light switches equal to the type denoted on the drawings.

8. All costs to provide 10 additional 3 way light switches equal to the type denoted on the drawings.
9. Provide 3 relay packs and 6 occupancy sensors to the owner.

PART 2 PRODUCTS

- A. Not Used

PART 3 EXECUTION

- A. Not Used

END OF SECTION

SECTION 26 00 30

WARRANTY PERIOD

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Procedures during the warranty period.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Division 26, Section 26 00 00, apply to this Section.
 - 1. Section 26 00 00 - Electrical

1.3 WARRANTY

- A. This Contractor shall warranty all work against defective materials and workmanship for a period of one year from and after date of acceptance of the installation by the owner.
- B. Neither the final payment nor any provisions in Contract Documents shall relieve this Contractor, or the Contractor, of the responsibility for faulty materials or workmanship.
- C. The contractor shall remedy any defects due thereto, and pay for any damage to other work resulting there from, which shall appear.
- D. This Warranty shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.4 MAINTENANCE SERVICE

- A. Provide normal maintenance services recommended by the manufacturer at no additional cost to the Owner during the warranty period.

PART 2 PRODUCTS

- A. Not Used.

PART 3 EXECUTION

- A. Not Used.

END OF SECTION

SECTION 26 00 90

ELECTRICAL SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This section supplements section 01 33 00 Submittal Procedures and contains additional requirements applicable to Division 26 submittals.

1.2 SECTION INCLUDES

- A. This section includes, but is not limited to:
 - 1. Electrical submittal procedures
 - 2. List of required Division 26 submittals to the engineer
- B. This section applies only to the Division 26 specifications. Submittals required by other specification divisions are not included here, even though the same subcontractor may be providing work under other divisions.

1.3 RELATED SECTION

- A. Section 01 33 00 – Submittal Procedures

1.4 SUBMITTALS

- A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the architect, engineer and owner.
- B. Manufacturers: Manufacturers submitted shall be as per the acceptable manufacturers listed in each specification section or referenced schedule. For additional manufacturers requiring approval, reference the Substitution of Products article in section 26 00 00.
- C. Required submittals: Refer to the Submittals article of each individual Division 26 specification section for the required items to be submitted.
- D. Color selection: Some products require that a color selection be coordinated with the architect. Information regarding such products shall be submitted to the architect.
- E. Contractor's coordination submittals: The contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the project, but such data shall remain between the contractor and his subcontractors and will not be reviewed by the engineer.
- F. Electronic Submittals: Provide submittals in pdf format. Paper submittals will be rejected.
- G. Coordination correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication, whether by mail, fax, or e-mail, will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the submittal package along with a copy of the correspondence.

- H. Unapproved products: If materials or equipment are installed before being reviewed and approved by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of unapproved materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.

1.5 PRODUCT DATA

- A. Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting color or highlighting. Data of a general nature shall not be acceptable.

1.6 SHOP DRAWINGS

- A. Scale and measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item.
- B. Types of prints required: Submit in pdf format.

1.7 SEQUENCING

- A. Submit product information within 30 calendar days after the contractor has received the owner's notice to proceed or in accordance with Architect's requirements, whichever is sooner.
- B. After the engineer has reviewed the submittals, make necessary revisions as directed by the engineer and resubmit.
- C. After the submittal has been reviewed and approved by the engineer, proceed to purchase materials and perform the work.

1.8 SCHEDULING

- A. Failure to submit items that meet the requirements of the contract documents in ample time for review shall not entitle the contractor to an extension of contract time, and no claim for extension by reason of such default shall be allowed. The contractor may be held liable for delays so occasioned.

PART 2 PRODUCTS

- A. Not applicable.

PART 3 EXECUTION

3.1 GENERAL

- A. Submit product data, shop drawings, samples, quality assurance submittals, quality control submittals, and other items in accordance with the requirements of this section, applicable sections in Division 1, and additional requirements of each individual Division 26 specification section.

3.2 SUBMITTAL ORGANIZATION

- A. Provide a submittal cover page that lists at least the following:
1. Project name
 2. Date
 3. Name and address of architect
 4. Name and address of engineer
 5. Name, address and telephone number of electrical distributor
 6. Name, address and telephone number of prime contractor
 7. Name, address and telephone number of electrical contractor
- B. Provide an index page listing all items submitted.
- C. The contractor shall call to the attention of the engineer by letter, included in the submittal after the index page, any instance in which the submittals are known to differ from the requirements of the contract documents.
- D. Organize all required items by specification section. All material for each specification section shall be in one single pdf file. Material for multiple specification sections may be combined into one file.
- E. The material for each specification section shall be organized as follows:
1. The first page shall indicate the specification number and title and the name, address and telephone number of the vendor or vendor's representative, if applicable.
 2. Refer to the individual Division 26 specification sections for any required organization of the submittal material within each submittal section.
- F. Submit in accordance with the procedures described in specification section 01 33 00 Submittal Procedures. PDF files are preferred.
- G. Submittals not organized as described here may be rejected, without being reviewed, as not complying with the provisions of the contract.

3.3 CLOSEOUT SUBMITTALS

- A. Provide close-out submittals in accordance with the requirements of Division 1.

3.4 SCHEDULES

- A. Division 26 Submittal Schedule: The Division 26 submittal shall include the following items for each Division 26 specification section that is in the contract documents. Coordinate this list with the submittal requirements listed in each specification section. If an item has been omitted from either list but is included in the other, then provide that item in the submittal. In case of conflicting or unclear requirements, contact the engineer.

Section	Submit on the following	1	2	3	4	Arch Sub #
26 05 19	Low-Voltage Electrical Power Conductors and Cables					
	Line voltage conductors					
26 05 26	Grounding and Bonding for Electrical Systems					
	Grounding materials and devices					
26 05 33.11	Raceways and Conduits for Electrical Systems					
	Raceways and conduit					

Section	Submit on the following	1	2	3	4	Arch Sub #
	Fittings					
	Wireways					
	Supports for rooftop conduits					
	Labeling					
26 05 33.13	Boxes and Fittings for Electrical Systems					
	Fittings					
	Cover plates					
	Junction boxes					
	Outlet boxes					
	Pull boxes					
	Floor boxes					
	Extension rings					
26 05 53	Identification for Electrical Systems					
	Label material					
	Sample identification tag					
26 09 13	Electrical Power Monitoring and Control					
	Metering equipment					
26 09 16	Time switches					
	Time switch product data					
26 09 21	Contactors					
	Contactors					
26 09 41	Lighting Controls					
	Motion Sensors					
	Wall sensors					
	Photocells					
	Smart switches					
	Time switches					
	Room controllers					
	Enhanced building controls (if required)					
	Software					
	Lighting contactors					
	Low voltage wiring					
	Shop drawing - RCP					
	Shop drawing - wiring diagrams					
	Sequence of operations for each unique space					
	List of switch types by unique space with proposed button labels					
	Motion Sensors					
	Wall sensors					
	Photocells					
	Smart switches					
	Time switches					
	Room controllers					
	Enhanced building controls (if required)					
	Software					
	Lighting contactors					

Section	Submit on the following	1	2	3	4	Arch Sub #
26 22 13	Low voltage distribution transformers					
	Transformers					
26 24 16	Panelboards					
	Switchgear					
	Electrical rooms (Drawn to scale & dimensioned)					
26 27 26	Wiring devices					
	Devices					
	Device plates					
	Keys					
26 28 13	Fuses					
	Fuses					
26 28 16	Enclosed Switches and Circuit Breakers					
	Safety switches					
26 28 19	Ground fault protection system					
	Ground fault protection equipment					
26 43 00	Surge Protective Devices (SPD)					
	Service entrance SPD					
	Sub-panel SPD					
	HVAC SPD					
26 50 00	Lighting					
	Luminaires					
	LED drivers					
	Battery backup units					
	Automatic transfer devices for emergency lighting					
	Product warranty documentation					
1 - Reviewed						
2 - Furnish as corrected in comments, resubmit not required						
3 - Revise and Resubmit based on comments						
4 - Rejected based on comments						

END OF SECTION

SECTION 26 05 11
ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.
- B. Off-site removal of materials not reused.

1.2 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 05 53 - Identification for Electrical Systems

PART 2 PRODUCTS

- A. Not used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing field measurements, circuiting arrangements, wiring and equipment served in areas as shown on the Drawings. Adjust all circuiting, wiring and materials to be provided as required by job conditions.
- B. Verify abandoned wiring and equipment serving only abandoned facilities.
- C. Drawings are based on casual field observation and existing record documents. Report discrepancies to the Engineer before disturbing existing installation.
- D. The Contractor accepts the existing conditions when beginning demolition.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors and ceilings as shown or required.
- B. Coordinate utility service outage with the respective utility company and the Owner.
- C. Provide temporary wiring and connections to maintain required existing systems in service during construction.
- D. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Verify phasing on existing equipment and coordinate new phasing before energizing revised service.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provision of Division 1 and this section.

- B. Remove, relocate and extend existing installations to accommodate new construction as required.
- C. Remove abandoned wiring to the source of the supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls, floors and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed in masonry construction.
- F. Disconnect and remove electrical devices and equipment serving equipment that has been removed.
- G. Disconnect and remove abandoned lighting fixtures. Remove brackets, stems, hangers and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations or as specified.
- K. Confirm with Owner or Architect regarding the handling and disposal/reuse of removed material, equipment, devices, lights, etc.

3.4 REPAIR/RESTORATION

- A. Clean and repair existing materials and equipment, in areas of revision, which remain or which are to be reused.
- B. Panelboards:
 - 1. Clean exposed surfaces and check tightness of electrical connections.
 - 2. Replace damaged circuit breakers and provide closure plates for vacant positions.
 - 3. Provide typed circuit directory showing revised circuiting arrangement as specified, on all existing switchgear.
 - 4. Provide new identification nameplates per Section 26 05 53.
- C. Luminaires:
 - 1. Remove existing luminaires for cleaning.
 - 2. Use mild detergent to clean all exterior and interior surfaces, rinse with clean water and wipe dry.
 - 3. Replace all lamps and ballasts as required along with all broken electrical parts and lenses.

3.5 RE-INSTALLATION

- A. Install all relocated materials and equipment under the provisions of Divisions 1 and 26.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section includes conductors for power circuits, including terminations and connectors.

1.2 RELATED SECTIONS

- A. Section 26 00 00 – Electrical
- B. Section 26 00 90 – Electrical Submittal Procedures.
- C. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- D. Section 26 05 19.19 – Metal Clad Cable
- E. Section 26 08 11 – Testing of Electrical System

1.3 REFERENCES

- A. ANSI/UL 83 - Thermoplastic-Insulated Wires
- B. ICEA S-61-402 -Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- C. UL 44 - Rubber Insulated Wires and Cables
- D. National Electric Code
- E. UL 493 -Thermoplastic Insulated Underground Feeder and Branch Circuit Cables

1.4 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 – Electrical Submittal Procedures.
- B. Product Data: Submit product data for the following:
 - 1. Conductors for power circuits
 - 2. Conductor terminations
 - 3. Connectors
- C. Closeout Submittals: Closeout submittals shall include the following.
 - 1. Submit letter certifying acceptable testing of all branch circuits.
 - 2. Submit insulation test results for all new feeders installed in this project.

1.5 QUALITY ASSURANCE

- A. General work practices for electrical construction shall be in accordance with NECA 1, Standard Practices for Good Workmanship in Electrical Construction.

- B. Regulatory Requirements: All products provided under this section shall be UL listed for the intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Material shall be stored in a clean and dry location until installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Conductors shall be manufactured in the United States. Acceptable manufacturers are:
 - 1. Encore Wire
 - 2. Southwire
 - 3. Cerro Wire
 - 4. General Cable
- B. All other manufacturers shall require pre-approval in accordance with specification section 26 00 00.

2.2 MATERIALS

- A. All feeders to be soft-drawn annealed copper.
- B. All branch circuit conductors shall be soft-drawn annealed copper.

2.3 MANUFACTURED UNITS

- A. Manufactured conductors for power circuits:
 - 1. All conductors for power circuits shall be rated for at least 600 volts.
 - 2. The insulation for power conductors shall be type THWN-2 or THHN/THWN.
 - 3. Conductors for power circuits shall be #12 AWG or larger.
 - 4. Conductors for power circuits that are #12 AWG or #10 AWG shall be solid. Conductors for power circuits that are #8 AWG and larger shall be stranded.
 - 5. Conductors sized #6 AWG and smaller shall have factory colored insulation.
- B. MC Cable: MC cable is allowed only for light fixture whips. Total length not to exceed six feet.
- C. Manufactured conductor terminations and connectors:
 - 1. All accessory materials such as connectors, splice and tap fittings, and terminations shall be of a type designed or intended and suitable for the use. They shall be compatible with the conductor material.
 - 2. Conductors shall be connected and terminated using suitable listed clamps, listed pressure connectors, listed compression terminals or listed lugs and hardware of the proper size for the application.
 - 3. Only connection devices that require the complete removal of the conductor jacket or insulation and result in a connection to the complete conductor surface area are suitable for use. Insulation piercing type connectors shall not be used.
 - 4. Splices and taps shall have a mechanical strength and insulation rating at least as that of the conductors.
 - 5. Compression systems shall include crimped die index and company logo for purposes of inspection. Aluminum shall not be used for connection purposes.

PART 3 EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

- A. Do not install the conductors until raceway system is complete.
- B. Before installing the conductors for any power circuit or feeder, verify that the conductor ampacity is at least as large as the rating of the overcurrent device protecting it. In the event that the conductors would not be adequately protected, notify the engineer before installation.

3.2 INSTALLATION

- A. Wire Sizing: Provide conductors sized as indicated on drawings unless modified as described below. Where conductor sizes have been omitted from drawings, base bid shall include conductors with ampacity as least as large as the overcurrent protection device protecting the conductors, or at least as large as the amp rating of the load being served, whichever is greater. In such cases, notify the engineer before installation for size verification.
- B. Neutral Conductors: Provide a separate neutral conductor for each circuit. Multiple circuits shall not share a common neutral. Neutral conductors shall be sized as large as the phase conductors. Neutral conductors shall not be of a reduced size.
- C. Equipment grounding conductors: Provide equipment grounding conductors in accordance with specification section 26 05 26 – Grounding and Bonding for Electrical Systems.
- D. Number of Conductors per Conduit: When #12 AWG conductors are used on 20-amp circuits, install no more than six conductors in a single conduit run. When #10 AWG conductors are used on 20-amp circuits, install no more than nine conductors in a single conduit run. Otherwise, there shall be no more than three conductors in each conduit run. The equipment grounding conductor shall not be counted for the preceding statements.
- E. Installation in Raceways:
 - 1. Install all conductors for power circuits in raceways.
 - 2. All conductors to be installed in a raceway shall be pulled together. Use an approved wire pulling compound when pulling large conductors.
 - 3. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of conductors.
 - 4. Do not exceed manufacturer's recommended values for maximum pulling tension.
 - 5. When installing conductors in existing conduit, the interior of the existing conduit shall be cleaned prior to the installation of the new conductors to insure that there is nothing that will damage the insulation.
 - 6. The pulling device shall be of a type that will not damage the raceway.
- F. Terminations:
 - 1. Use pressure type lugs or connectors for terminations or splices of all stranded conductors. Use ring tongue type terminators on all control wiring. More than one conductor shall not be installed in any termination unless the termination is marked as suitable for more than one conductor. With the written approval of the engineer's office, an exception to this may be allowed for the installation of the surge protective devices required in specification section 26 43 00 Surge Protective Devices.
 - 2. Conductors shall not be supported solely by their terminations.
 - 3. Terminations shall be made such that the stripped length of the conductor is no longer than required for the terminal, lug, or connector.
 - 4. Conductive antioxidant shall be applied on all outdoor connections and connections in damp or wet locations.

- G. Splices:
1. Conductor splices shall be kept to a minimum.
 2. Where splices are necessary, they shall be in a box or enclosure. Splices within a conduit run are not acceptable.
- H. Color Coding:
1. Provide factory colored insulated conductors for #6 AWG and smaller.
 2. Color code larger insulated conductors with an approved field-applied tape 2" wide on each end of conductors.
 3. If existing wiring in renovation or addition work has a consistent color coding, then match the existing and note in record documents. Otherwise, colors shall be as follows:

Line	208/120V	240/120V	480/277V
A	Black	Black	Brown
B	Red	Orange	Orange
C	Blue	Blue	Yellow
Neutral	White	White	Gray
Ground	Green	Green	Green
Isolated Ground	Green + Yellow	Green + Yellow	Green + Yellow
 4. Switch leg shall be the same color as the un-switched phase wiring. Travelers, and special systems as selected by the Contractor. Note in record drawings.
- I. Identification: All conductors in a panelboard shall be identified by means of tags or tape.

3.3 SITE TESTS

- A. Perform in accordance with manufacturer's printed testing procedures, applicable industry standards, ANSI standards, IEEE standards, and NEMA standards. Provide testing equipment in good working order and which complies with the applicable industry standards and manufacturer's requirements. Submit a list of testing equipment used and date of last calibration.
- B. Insulation Test: The insulation of each feeder run and each branch circuit shall be tested. The test shall be performed after the conductors have been pulled into the conduit and after terminations have been added, but before final connections are made.
- C. Test the following:
1. Phase to phase resistance
 2. Phase to neutral resistance
 3. Phase to ground resistance
 4. Neutral to ground resistance
- D. Branch Circuits: The insulation of branch circuits may be tested with a standard ohm meter. Readings must indicate an open circuit to be acceptable. Submit letter documenting that all circuits have been tested and are acceptable.
- E. Feeders:
1. Perform megger tests on all new feeder runs.
 2. Tests shall be performed in accordance with the Publication "Instruction Manual For Megger Insulation Testers" by the Biddle Company.
 3. Written documentation of the test results shall be submitted in accordance with specification section 26 08 11 – Testing of Electrical System.

END OF SECTION

SECTION 26 05 19.19

METAL CLAD CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section includes the following:
 - 1. Metal Clad (Type MC) and Metal-Clad Interlocking Armor Ground Cable (Type MCI-A).
 - 2. Wiring connections and terminations.
 - 3. Installation methods and procedures.

1.2 RELATED SECTIONS

- A. 26 05 19 - Low Voltage Electrical Power Conductors and Cables
- B. 26 05 26 - Grounding and Bonding for Electrical Systems
- C. 26 08 11 - Testing of Electrical System

1.3 REFERENCES

- A. UL 83 - Thermoplastic Insulated Wires and Cables
- B. UL 1569 - Standard for Metal Clad Cables
- C. NEC - NFPA 70, National Electrical Code 2014
- D. ASTM B3 - ASTM International Standard B3 Standard Specification for Soft or Annealed Copper Wire
- E. ASTM B8 - ASTM International Standard B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- F. ANSI/NETA ATS - International Electrical Testing Association Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, 2013 edition

1.4 SUBMITTALS

- A. Product Data Submittals: Submit product data for each type of metal clad cable and fitting indicated.
- B. Quality Assurance/Control Submittals: Submit qualification data for testing agency.
- C. Closeout Submittals: Submit field quality-control test reports.

1.5 QUALIFICATIONS

- 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.

- B. 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, Underwriter's or other approved label, grade or identifying number.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. AFC Cable Systems, Inc. or approved equivalent.

2.2 ARMORED CABLE ASSEMBLY

- A. Metal clad cable assemblies shall consist of 2 or more insulated current carrying copper conductors and a green insulated copper ground conductor. The metal clad cable (or armored cable assembly) shall be UL classified as a through-penetrating product (XHLY) for use in one, two or three-hour through-penetration firestop systems (XHEZ). The assembly shall be suitable for use in cable trays in accordance with the NEC.
- B. Current-Carrying Conductors: Soft annealed copper in compliance with the latest edition of ASTM B3 and/or B8; size 12 AWG through 6 AWG. A separate neutral conductor shall be supplied with each phase conductor. Neutral conductor shall be oversized where indicated on the plans.
- C. Insulated Equipment Grounding Conductor: The equipment ground shall be a full-sized insulated conductor with a protective cover, sized in accordance with Table 6.1 of UL 1569. The grounding conductor shall be soft-annealed copper in compliance with the latest edition of ASTM B3 and/or B8.
- D. Isolated Grounding Conductor: An additional isolated, insulated grounding conductor shall be provided where specified in section 26 05 26. The isolated ground shall be a full-sized insulated conductor with a protective cover, sized in accordance with Table 6.1 of UL 1569. The isolated grounding conductor shall be soft-annealed copper in compliance with the latest edition of ASTM B3 and/or B8.
- E. Conductor Insulation: The insulated conductors shall be type THHN 90°C DRY with an extruded polypropylene protective covering. The insulated conductors with protective covering shall be manufactured and tested in accordance with UL 83 and UL 1569.
- F. Armor: A zinc coated galvanized steel armor shall be applied over the cabled wire assembly with an interlock in compliance with Section 13 of UL 1569. Armor shall be colored to identify the voltage and number of conductors.

2.3 FITTINGS

- A. Fittings shall be UL listed and identified as MCI-A for such use with metal clad interlocking armor ground.
- B. Connectors shall be of steel or malleable iron and shall have saddle clamp to insure a tight termination of MC or MCI-A cable to box.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Scope: Provide metal clad cable for lighting. Provide metal clad cable for exterior circuits, including area lighting circuits.
- B. Interior Routing: Route metal clad cable runs parallel with or perpendicular to walls or structural elements. Route horizontal runs level. Route vertical runs plumb. Rack groups together neatly with both straight runs and bends parallel and uniformly spaced.
- C. Supporting: Provide support for MC cable in accordance with NEC Article 330 or the following, whichever is more stringent.
 - 1. Use of cable tray: Basket, ladder rack, or ventilated cable tray may be utilized for support of metal clad cabling. The sum of the cross-sectional areas of cables shall not exceed the maximum allowable cable fill area allowed by NEC Article 392. Ampacity of cables installed in cable tray shall meet the requirements of NEC 392.80.
 - 2. In existing buildings, provide independently supported cable hangers. These hangers are to be suitable for installation of MC cable.
 - 3. In new buildings, provide a combination of cable tray and/or J cable hangers.
 - 4. Individual metal clad cables hung from roof structure or structural ceiling shall be supported by split-ring hangers and wrought-iron hanger rods. Where three or more metal clad cables are suspended from the ceiling in parallel runs, use steel channels, Unistrut or equal, hung from 1/2-inch (13 mm) rods to support the cables. The cables on these channels shall be held in place with metal clad cable clamps designed for the particular channel that is used.
 - 5. Secure metal clad cable support racks to concrete walls and ceilings by means of cast-in-place anchors; die- cast, rustproof alloy expansion shields; or cast flush anchors. Wooden plugs, plastic inserts, or gunpowder driven inserts shall not be used as a base to secure conduit supports.
 - 6. Support metal clad cable immediately on each side of a bend and not more than 1 foot (300 mm) from an enclosure where a run of metal clad cable ends.
- D. Clearances: Maintain clearances described below.
 - 1. Where metal clad cable is installed parallel to framing members, such as studs, joist, or rafters, support the cable so that the nearest outside surface of the cable is at least 1-1/4 inches (31 mm) from the nearest edge of the framing member. Where this distance cannot be maintained, protect the cable by a steel plate, sleeve, or equivalent that is at least 1/16-inch thick.
 - 2. Maintain at least 6-inch clearance between metal clad cables and other piping systems.
 - 3. Maintain 12-inch (300 mm) clearance between metal clad cables and heat sources such as flues, steam pipes, and heating appliances.
 - 4. No metal clad cable shall be fastened to other conduits or pipes or installed so as to prevent the ready removal of other pipes or ducts for repairs.
- E. Fittings: Follow manufacturer's instructions for cable preparation for installation of fittings. Cleanly cut the cable end with metal clad cable rotary cutting tool to ensure flush seating of the cable into the fitting. Properly torque fitting securement screws.
- F. Splices and Terminations: Make splices at junction boxes with an approved, insulated, live spring type connector such as those manufactured by Scotchlock, 3M or Ideal.
- G. Conductors in Enclosures: Provide neat and workmanlike installation with conductors tied with nylon wire ties in terminal cabinets, gutters and similar locations.

- H. Terminating metal clad cables into panelboards:
 - 1. Provide a junction box within plenum space with sweep elbows down to panelboard, or
 - 2. Use a ladder tray mounted vertically above the panelboard. Strap cables to rungs and install cover on cable tray.
- I. Identification: Identify all wiring with permanent wire labels, using alphanumeric designations. Terminations and splices shall be identically labeled for the same wire (i.e. common conductors terminated in multiple locations). Wire labels shall agree with the circuit designations on the Construction Drawings. Identify conductors in outlets, pull boxes and similar locations where conductors are accessible with printed plastic adhesive tapes to show circuit numbers. Wrap tapes at least two turns around conductor. Mark panel identification number with felt tip pen on cloth or plastic tag and attach to entering conductors with nylon string.

3.2 SITE TESTS, INSPECTION

- A. Hire an independent testing agency to perform acceptance testing.
- B. All fittings and locknuts shall be re-examined for tightness. A continuity test is to be performed at each connection as a final means of inspection for tightness of joints.
- C. Perform site tests in accordance with sections 26 08 11 and 26 05 19.
- D. Perform field tests in conformance with the ANSI/NETA ATS.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 08 11 - Testing of Electrical System

1.4 REFERENCES

- A. National Electrical Code
- B. ANSI/IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- C. ANSI/UL 467 - Safety Standard for Grounding and Bonding Equipment.

1.5 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.
- B. Submit grounding materials and devices to be used.
- C. Submit test results of megger reading to Engineer after installation of grounds with records for Owner.
- D. Revisions to grounding will be to satisfaction of the Engineer at no cost by the Contractor.

PART 2 PRODUCTS

2.1 GROUND RODS

- A. Copper cladding permanently bonded to a high-strength steel core, molten welded to core.
- B. 3/4 inch by 10 feet (19mm by 30m) Straight, Conform to UL 467.

2.2 CONNECTIONS

2.2.1 GENERAL CONNECTION REQUIREMENTS

- A. Listed and labeled as grounding connectors for the materials used.

2.2.2 OUTDOOR & BELOW GRADE GROUNDING CONNECTIONS

- A. Welded.
- B. Provide starting material in kit form.
- C. Aluminum, copper and iron oxide.
- D. No phosphorous or any other caustic, toxic or explosive substance may be used.
- E. Manufacturer/Model
 - 1. Erico Products "Cadweld Exothermic"
 - 2. Thermoweld

2.2.3 OUTDOOR & ABOVE GRADE GROUNDING CONNECTIONS

- A. Bonds and clamps.
- B. Non-ferrous material which will not cause electrolytic action between the conductor and connector.
- C. Provide exothermal welding where clamping is not accessible.

2.2.4 INDOOR GROUNDING & POWER CONNECTIONS

- A. Provide clamps as listed for outdoor applications.
- B. Use low smoke/low emission welding where not accessible.
- C. Manufacturer/Model: Erico Products "Cadweld Exolon".
- D. Service Entrance Grounding Connections: U-bolt with pressure plate.

2.3 WIRING

- A. Copper 600 volt insulated conductors with a green-colored insulation for bonding.
- B. Grounding conductors to be in accordance with NEC Table 250-95.
- C. Bonding jumpers to be minimum cross-sectional area greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250-95.
- D. Use to ground electrode and equipment grounding conductors.

2.4 MISCELLANEOUS CONDUCTORS

- A. Ground Bus: Bare annealed copper bars of rectangular cross section. 98% IACS conductivity, not less than 25% of feeders cross section area.

- B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch (1mm) thick and 2 inches (50mm) wide, except as indicated.

2.5 SERVICE ENTRANCE GROUNDING SYSTEM

- A. Material:
 - 1. Type K copper hollow tube filled with non-hazardous metallic salts.
 - 2. Diameter: 2-1/8 inch
 - 3. Length: 10 feet
 - 4. Type: Straight
- B. Manufacturer/Model
 - 1. XIT Grounding Systems, K2-10 Series
 - 2. Equals per XIT design and specifications

2.6 LIGHTNING ARRESTORS

- A. Manufacturers: Products of the following manufacturers which meet the requirements of these specifications are acceptable.
 - 1. Anixter Brothers, Inc.
 - 2. Blackhawk Industries
 - 3. Burndy
 - 4. Copperweld Corporation
 - 5. Erico Products, Inc.
 - 6. Ideal Industries, Inc.
 - 7. IlSCO
 - 8. ITT Blackburn
 - 9. Joslyn
 - 10. OZ/Gedney Co.
 - 11. Raco, Inc.
 - 12. Thomas & Betts Corp

PART 3 EXECUTION

3.1 APPLICATION

3.1.1 EQUIPMENT GROUNDING CONDUCTOR APPLICATION

- A. Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
- B. All power circuits shall be provided with a separate copper insulated equipment grounding conductor (EGC) run in the raceway with the power conductors. The conduit is not to be used as the sole means of grounding. The insulation of the EGC shall be green.
- C. Bonding to the EGC shall be provided at each end of metallic conduit runs and at all boxes and enclosures.
- D. All branch circuits and feeders that require an isolated ground (IG) equipment grounding conductor shall be provided with a separate copper insulated IG equipment grounding conductor run in the raceway with the power conductors. The IG equipment grounding conductor shall be provided in addition to the normal EGC. The insulation of the IG equipment grounding conductor shall be green with a yellow stripe.

- E. Conduits and boxes of IG circuits shall be bonded to the normal EGC as stated above. At outlet locations, the IG equipment grounding conductor shall connect only to the isolated ground terminal of an isolated ground outlet. There shall be no connection, either directly or indirectly, between the normal EGC and the IG equipment grounding conductor at any point other than at the source of a separately derived system (transformer) or at the service entrance.
- F. The following circuits shall be provided with an IG equipment grounding conductor:
 - 1. Feeders providing power to panels equipped with an IG buss.
 - 2. All branch circuits originating at a panel with an IG buss.

3.1.2 COMMUNICATIONS

- A. For communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location.

3.1.3 METAL POLES SUPPORTING OUTDOOR LIGHTING FIXTURES

- A. Ground pole to a grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.

3.2 INSTALLATION

3.2.1 GENERAL

- A. Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.

3.2.2 GROUND RODS

- A. Locate a minimum of one-rod length from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches (600 mm) below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use 3/4 inch by 10-ft. (19mm by 30 m) ground rods except as otherwise indicated. Drive rods until tops are 6 inches (150mm) below finished floor or final grade except as otherwise indicated. Provide "Powerfill" "Gem" or equal conducting material in quantity recommended by manufacturer at all ground rods.

3.2.3 METALLIC WATER SERVICE PIPE

- A. Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fittings. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.
- B. Route bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, electric heaters, and air cleaners serving individual systems.

3.2.4 GROUND

- A. Fabricate with 20 feet (60m) of conductor laid lengthwise in excavation for foundation or footings. Install so conductor is within 2 inches (50mm) of the bottom of the concrete. Where base of foundation is less than 20 feet (60m) in length, coil excess conductor at base of foundation. Bond conductor to reinforcing steel at four locations, minimum. Extend conductor below grade and connect to building grounding electrode.

3.3 CONNECTIONS

3.3.1 GENERAL

- A. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
- B. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series. Make connections with clean bare metal at points of contact.
- C. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps. Aluminum to galvanized steel connections will be with tin-plated copper jumpers and mechanical clamps.
- D. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

3.3.2 EXOTHERMIC WELDED CONNECTIONS

- A. Use for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- B. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushing and bare grounding conductors.
- C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

3.3.3 COMPRESSION-TYPE CONNECTIONS

- A. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

3.3.4 MOISTURE PROTECTION

- A. Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

3.4 TESTS

- A. Subject the completed grounding system to megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal, and at ground test wells. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System". Submit test results in accordance with Section 26 08 11 - Testing of Electrical System.
- B. Ground/resistance maximum values shall be as follows:
 - 1. Equipment rated 500 kVA and less: 10 Ohms
 - 2. Equipment rated 500 kVA to 1000 kVA: 5 Ohms
 - 3. Equipment Grounds: 25 Ohms

3.5 CLEANING AND ADJUSTING

- A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying and other work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform such work in accordance with Division 2 Section. Maintain disturbed surfaces, restore vegetation and restore disturbed paving as indicated.

END OF SECTION

SECTION 26 05 33.11

RACEWAYS AND CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Electrical raceway and conduit systems.

1.3 RELATED SECTIONS

- A. Division 28 - Electronic Security and Safety
- B. Section 26 00 00 - Electrical
- C. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- E. Section 26 21 00 – Low Voltage Electric Service Entrance

1.4 REFERENCES

- A. ANSI/ANSI C80.1 - Zinc-Coated Rigid Steel Conduit
- B. ANSI/ANSI C80.4 - Zinc Coated Electrical Metallic Tubing
- C. ANSI/ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
- D. ANSI/UL 1 - Flexible Metal Conduit
- E. ANSI/UL 5 - Surface Metal Raceways and Fittings
- F. ANSI/UL 651 - Rigid Nonmetallic Conduit
- G. ANSI/UL 797 - Electrical Metallic Tubing
- H. ANSI/UL 870 - Safety Standard for Wireways, Auxiliary Gutters and Associated Fittings
- I. ETL PVC-001 - PVC-Coated Rigid Steel Conduit
- J. NEMA TC2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80) and Fittings
- K. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- L. UL 6 - Rigid Metal Electrical Conduit
- M. UL 360 - Liquid tight Flexible Steel Conduit

N. UL 467 - Electrical Grounding and Bonding Equipment

1.5 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements. Included in this section are all raceways and conduit, fittings, wireways, supports for conduit on roof, and labeling used. Provide samples upon specific request. U.L. labels affixed to each item of material.

1.6 DESCRIPTION OF WORK

- A. The use of the various raceway systems is restricted to the types and other restrictions of the NEC and the local codes. Use of all such systems shall be verified with the local code authority before use. In the case of questionable or denied use, the contractor shall be required to use a raceway system permitted by the local code at no additional cost.
- B. Where conduits pass through beams, outside walls, fire rated walls, or structural members, galvanized steel pipe sleeves shall be provided. The size of these sleeves shall be such as to permit readily the subsequent insertion of conduit of the proper size with adequate clearance for movement due to expansion and contraction. Where conduits pass through outside walls, the inside diameter of the galvanized iron pipe sleeves shall be at least 1/2" greater than the outside diameter of the service pipe. After the conduits are installed, fill the annular space between the conduit and its sleeve with a mastic or caulk. Use packing as required to accomplish this. At fire rated wall penetrations, use fire barrier.
- C. Grounding: The installation shall comply with all NEC grounding requirements. See specification section 26 05 26 Grounding and Bonding for Electrical Systems for additional grounding requirements.
- D. Exposed surface raceways are specifically not permitted, in new construction. Where a raceway is required, in existing construction, it shall be solid, without knockouts, with hinged cover, placed so that cover is gravity closed.
- E. Install complete, separate conduit systems for all electrical systems on this project to include, but not limited to include the following.
1. New service entrance.
 2. Electrical power and lighting feeders
 3. Electrical power and lighting circuits
 4. Isolated ground (computer "clean power") circuits
 5. Control wiring furnished by this contractor
 6. Emergency and standby power and lighting circuits
 7. Communication systems
 8. Other electrical systems
- F. Branch circuits shall not be installed in or under the ground floor slab and will not be accepted. The only exceptions being circuits and locations specifically required on the drawings to be in or under the floor slab.
- G. Aluminum conduit shall not be installed in direct contact with concrete or masonry construction.

PART 2 PRODUCTS

2.1 CONDUITS AND FITTINGS

2.1.1 MINIMUM SIZES

- A. Do not use conduit sized less than 3/4 inch steel, 3/4 inch for PVC conduit, 3/8 inch flexible metal conduit, for lengths not to exceed 72 inches supplying light fixtures.

2.1.2 RIGID METAL CONDUIT. (RSC) (RAC) (IMC)

- A. Hot-dipped galvanized rigid steel (RSC), Intermediate Metallic (IMC) with zinc-coated threads and an outer coating of zinc chromate, Rigid Aluminum (RAC) accepted.
- B. Fittings:
 - 1. Malleable iron, either cadmium plated or hot-dipped galvanized. Die cast zinc. Aluminum for aluminum conduit. To be insulated throat at terminations.
 - 2. Use of set screw or bolt-on connectors and couplings is not accepted.
 - 3. Use deflection and expansion couplings with bonding jumpers at all expansion joints where required. Steel Clamps.
- C. Usage: Where exposed on interior and exterior of buildings including roof. All elbows of PVC conduit. Within or penetrating concrete slabs (RSC only).

2.1.3 PVC COATED RIGID METAL CONDUIT

- A. NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6 and ETL PVC-001. The PVC coated galvanized rigid conduit must be ETL Verified to the Intertek ETL SEMKO High Temperature H2O PVC Coating Adhesion Test Procedure for 200 hours.
- B. Fittings
 - 1. Malleable iron. Steel.
 - 2. Use fittings listed and labeled as complying with UL514B.
 - 3. Exterior Coating: Polyvinyl Chloride (PVC), minimum thickness of 40 mils.
 - 4. Interior Coating: Urethane, minimum thickness of 2 mils.
- C. Usage: Damp or wet locations. The stub-up from below grade to above grade

2.1.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Galvanized Electrical Steel, Galvanized Thin Wall, or Aluminum Tubing
- B. Fittings: Set screw or compression type. Indenter type is not accepted. Die cast zinc. Pressure cast. Malleable iron. Steel. Steel Clamps. To be insulated throat at terminations.
- C. Usage: Concealed in interior walls and ceiling spaces. Exposed only in interior mechanical, electrical rooms, and equipment rooms. Gyms, activity spaces, stages as directed, above 10'-0" A.F.F. where exposed. Installation in or under the floor slab will not be accepted.

2.1.5 RIGID NONMETALLIC CONDUIT (RNC)

- A. Schedule 40 heavy wall polyvinylchloride, high impact resistant.
- B. Fittings: Solvent weld socket type

- C. Usage: Underground, under slabs, all bends to be rigid steel. Do not penetrate slab with PVC. Do not use above slabs, above grade, or exposed. Use long sweep rigid steel 90's and rigid steel from 90's to and above grade.

2.1.6 FLEXIBLE METAL CONDUIT (FMC)

- A. Spiral-wound, square-locked aluminum. Spiral-wound, square locked, hot-dipped galvanized steel.
- B. Fittings: Cadmium plated two-screw, double-clamp malleable iron. Hot-dipped galvanized two-screw, double-clamp malleable iron. Malleable. Pressure cast. Steel cast. Steel/Malleable for 90°. Zinc coated, aluminum. To be insulated throat at terminations.
- C. Usage:
 - 1. May be used for light fixture whips.
 - 2. May be used for final equipment connections, such as transformers, motors and HVAC equipment.
 - 3. Total length not to exceed 72" above ceiling, 48" exposed below ceiling.
 - 4. Exposed only in interior mechanical or electrical rooms.
 - 5. For renovation work, may be used in existing walls only under the following conditions:
 - a. The use of EMT or rigid conduit is not feasible.
 - b. Written permission has been obtained from the engineer.
 - c. Surface mounted conduit is not desired.
 - 6. Installation in or under the floor slab will not be accepted.

2.1.7 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFC)

- A. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.
- B. Fittings:
 - 1. Cadmium plated, compression type, malleable iron. Hot-dipped galvanized, compression type, malleable iron. To be insulated throat at terminations.
 - 2. Aluminum - Copper free (1% or less)
- C. Usage:
 - 1. Exterior equipment - 5' 0" Maximum length
 - 2. Kitchen equipment - 4' 0" Maximum length

2.1.8 ACCEPTABLE MANUFACTURERS

- A. Metallic Conduits: Pittsburgh, Alfex, AFC, Wheatland, Allied, Omega, Spang, and Nepco.
- B. Nonmetallic Conduits: Carlon, Sedco, and Can-Tex.
- C. PVC Coated Metallic Conduits: Plasti-Bond, Perma-Cote, and KorKap.
- D. Fittings: Madison, Hubbell, Raco, Regal, Appleton, Thomas & Betts, Steel City, and ECN Korns.
- E. Others: As listed with products.

2.2 WIREWAYS

- A. Not less than 16 gauge sheet steel. Cross section dimensions not less than 4 inches by 4 inches, or as noted. ANSI gray epoxy paint over rust-inhibiting prime coat. NEMA rated. Large

enclosed surface metal raceway used where conduit is not accessible, or use of conduit is not feasible.

- B. Manufacturers: Square D., Hoffman

2.3 METALLIC SURFACE RACEWAYS

- A. Not less than 0.04" thickness sheet steel with enamel over rust-inhibiting prime coat, ivory finish, not less than 0.25 square inch cross section.
- B. One piece for up to 7 - #12 AWG wire capacity.
- C. Two piece for up to 8 - #12 AWG wire or more capacity.
- D. Usage: Exposed on existing classroom and public walls where concealment of EMT or FMC is prohibitive, and/or in lieu of rigid metal conduit. Use deep boxes for mounting fire alarm devices.
- E. Manufacturers: Wiremold, Tehalit, Mono-Systems, Panduit

2.4 NON-METALLIC SURFACE RACEWAYS

- A. Rigid polyvinyl chloride (pvc), ivory finish, not less than .20 square inch cross section. Two piece construction, minimum 5 - #12 AWG wire capacity.
- B. Usage: Exposed on existing walls, as noted on drawings, where concealment of EMT or FMC and/or in lieu of rigid metal conduit is prohibitive. Use deep boxes for mounting fire alarm devices.
- C. Manufacturers: Tehalit, Wiremold, Hubbell, Mono-Systems, Panduit

2.5 POWER/DATA RACEWAYS

- A. Wiremold AL4320 series, two compartment, with isolated ground duplex receptacles and data devices as noted on drawings. Provide all required mounting accessories. Serve raceways from flush outlet boxes mounted behind raceway as required and as directed.

PART 3 EXECUTION

3.1 PREPARATION

- A. Place sleeves in the cavities of walls and floor slabs for the free passage of conduits.
- B. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work.
- C. Apply caulking for sleeves through floors and through exterior walls.
- D. Be sure that plugs or caps are installed before concrete placement begins.

3.2 INSTALLATION

3.2.1 CONDUITS

- A. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to

enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. At conduit terminations, provide insulated throat fittings. Where conduits terminate in equipment having a ground bus, such as in switchgear, and panelboards, provide conduit with an insulated grounding bushing.

- B. It is intended to reuse the existing conduits in existing construction, if they prove to be adequate in size and integrity.
- C. Install conduit and tubing products as indicated, in accordance with applicable requirements of NEC and the NECA "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.
- D. Cap open ends of raceways until conductors are installed.
- E. Wherever possible and unless otherwise indicated on the drawings, install conduit concealed in walls, partitions and above the ceiling. Install conduit exposed in ceiling area at the structure in electrical rooms, mechanical rooms and other rooms where ceilings are not present or scheduled.
- F. In mechanical rooms install conduit to equipment not adjacent to walls, by dropping conduits exposed from overhead.
- G. Install conduits parallel and supported on Unistrut or equal trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. Wire ties are not permitted. Do not support conduit from ceiling system supports.
- H. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be followed To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit.
- I. Liquid-tight flexible metal conduit on the roof shall be securely fastened in place by an approved means within 12 inches of each box, cabinet, conduit body, or other conduit termination, and shall be supported and secured at intervals not to exceed 4.5 feet. Flexible conduit cannot lay on roof.
- J. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection. Run green ground wire in all PVC conduit and extend to ground bus.
- K. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Branch circuits installed in or under slabs on grade will not be accepted unless noted on drawings. Branch circuits shall be installed below floor slabs above first floor.
- L. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors. See Section 26 05 19 Conductors for additional requirements for installation of conductors in raceways.
- M. Conduit and raceways shall be suspended from building structure, not from ceiling suspension system.
- N. Make bends with standard ells or conduit bent in accordance with the NEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

- O. Securely fasten and support all conduit runs. Provide required clamps, straps, clips, hangers and brackets. Raceways run in joists shall be secured to joists with clamps at 20'0" maximum spacing. Raceways run parallel to joists shall be supported by caddy clips (1 inch or smaller) or in unistrut/threaded rods/beam clamps trapeze at 15'-0" centers. Raceways run perpendicular to bottom of joists shall be secured with individual conduit hangers at 10'-0" maximum spacing or unistrut/threaded rods/beam clamps at 15'-0" maximum centers. Raceways supported by straps at walls shall be supported per NEC. Support all raceways within one foot of each box, cabinet, disconnect, bend or other raceway termination.
- P. Run flexible conduit to all recessed fluorescent fixtures in accessible ceilings. Do not use more than 4 flexible metal conduits per junction box to supply light fixtures in a location. Do not supply a fixture from another with any Raceway or FMC. Suspend junction boxes and conduits from high roofs with hangers and trapeze.
- Q. Provide two spare 1 inch conduits stubbed into attic space at flush mounted electrical cabinets.
- R. Provide a Greenlee #431 or equal (240 lbs.) nylon pulling line in conduits in which wiring is not installed under this work, such as telephone, signal, and similar systems. Identify both ends of the line by means of labels or tags reading "Pulling Line".
- S. Use expansion-deflection fittings on conduits 2 inches and larger crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.
- T. Openings around electrical penetrations of fire resistance rated walls, partitions, floors or ceilings shall be made using approved methods so as to maintain the original fire resistance rating. See NEC 300-21.
- U. See Section 26 21 00 for additional requirements for conduit at the electrical service.

3.2.2 WIREWAYS

- A. Install wireways, where noted or required. Field apply a 90 percent grey zinc paint coating over cuts or scratches before any other finish is applied.

3.2.3 SURFACE RACEWAYS

- A. Install surface raceways, where noted or required. At metallic raceways, field apply a 90 percent zinc paint coating to cuts or scratches before any other finish is applied.

3.2.4 COMMUNICATION SYSTEMS

- A. This contractor shall provide all raceways and conduits for all communication systems shown and/or required on the drawings. Communication Systems may include but are not limited to fire alarms, intercoms, telephones, television, security, computer data, antenna and media management.
- B. Raceways and conduit requirements shall be coordinated by this contractor with each Communication Systems Contractor and the general contractor.
- C. See Specification Division 28 for additional requirements.

3.3 COLOR CODING

- A. Provide color bands approximately two inches wide, applied at 10 foot centers and at pull box locations.
- B. Color Codes:
 - 1. Fire Alarm System Red
 - 2. Voice/Data Blue
 - 3. Security System Green
 - 4. Media Management Yellow
 - 5. CATV/MATV Black

3.4 LABELING

- A. Type: Write-on markers with a laminating portion for protection. The writing portion shall be white in color. The laminate portion shall be clear.
- B. Installation:
 - 1. Install the write-on markers with the protective laminates securely over the write-on markers.
 - 2. Install and label the write-on markers and laminates on conduits in accessible attic space at 4 to 6 inches above the point where the conduit exits the wall. If a conduit cannot be labeled in this manner, install and label the write-on markers and laminate behind the cover plate of the systems electrical box.
 - 3. Where a junction box is to be installed for future use, install and label the conduit on the cover plate as outlined above as to the destination of the raceway (i.e. panelboard, fire alarm panel, intercom panel, room name etc.).
 - 4. Label all boxes in a legible manner.
- C. Systems To Be Labeled:
 - 1. CATV/MATV system
 - 2. Fire Alarm system
 - 3. Voice/Data system
 - 4. Media Management system
 - 5. Security system

END OF SECTION

SECTION 26 05 33.13

BOXES AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Outlet boxes
- B. Junction boxes
- C. Pull and splice boxes

1.3 RELATED SECTIONS

- A. Division 28 - Electronic Security and Safety
- B. Section 26 00 00 - Electrical
- C. Section 26 27 26 - Wiring Devices

1.4 REFERENCES

- A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports, and Cast Aluminum Covers.
- B. ANSI/UL 514 - Electrical Outlet Boxes and Fittings.
- C. NEC 370-23(d)

1.5 DESCRIPTION OF WORK

- A. The extent of electrical box and electrical fitting work is indicated by drawings and the requirements of this section.
- B. The types of electrical boxes and fittings required for the project include the following:
 - 1. Outlet boxes
 - 2. Junction boxes
 - 3. Pull boxes
 - 4. Conduit bodies

1.6 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.
- B. Include cut sheets of fittings, cover plates, junction boxes, outlet boxes, pull boxes, floor boxes and extension rings. Provide samples upon specific request.

PART 2 PRODUCTS

2.1 OUTLET BOXES

- A. Flush Device Boxes
 - 1. Galvanized steel boxes, with extension rings as required. Use 1½ inch deep by 4 inches long, square or rectangular, unless otherwise noted on drawings.
 - 2. Provide galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
 - 3. In boxes with multiple switches, where the voltage between adjacent switches exceeds 300 volts, provide an enclosure equipped with identified, securely installed barriers between adjacent devices.
- B. Exterior or Exposed Device Boxes: Use FS or FD cast boxes with threaded hubs.
- C. Interior Lighting Fixture Boxes: Galvanized steel with fixture stud supports and attachments to properly support ceiling and bracket-type lighting fixtures. Provide galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides and with threaded holes with screws for securing box covers or wiring devices. 1½ inch deep by 4 inches wide octagonal box, unless otherwise noted.
- D. Voice & Data Outlet: Provide back boxes at each voice and data outlet. Communications wiring, device and plate to be provided by communications contractor. See Specification Division 28 for additional requirements.
- E. Masonry Boxes: Galvanized steel with gang capacity and extension ring covers to match the number of devices installed.

2.2 JUNCTION, PULL AND SPLICE BOXES

- A. Galvanized steel boxes conforming to NEC Article 370.
- B. Use NEMA 1 type boxes at least 4 inches deep, interior spaces.
- C. Use NEMA 3R type boxes at least 4 inches deep, exterior spaces.
- D. Use NEMA 4 cast iron type with external recessed flanged cover when cast in concrete.

2.3 MANUFACTURERS

- A. Appleton
- B. Hoffman
- C. Hubbell
- D. Keystone
- E. Lew
- F. Orbit Industries

- G. Raceway Components
- H. RACO
- I. Stahlin
- J. Steel City
- K. Walker

PART 3 EXECUTION

3.1 OUTLET BOXES

3.1.1 GENERAL

- A. Provide all standard boxes, pull junction, wiring device and/or splice boxes for all systems in walls and slabs.
- B. All low voltage systems in attic or crawl spaces specified in Division 23 are not included.
- C. At all ceiling-mounted receptacle and luminaire (exit light, pendants, linear direct/indirect, etc.) locations, provide a heavy duty dual bar hanger with ceiling ties to support the back box. Provide Cooper Industries BA50F or approved equal with appropriate back box for the application.

3.1.2 FLUSH BOXES

- A. Mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line unless otherwise indicated. Provide knockout closures to cap unused knock out holes where knock out holes have been removed. Install outlets flush with finish walls or ceiling surfaces for concealed wiring.
- B. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Install electrical boxes and fittings in compliance with NEC requirements and in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes.
- C. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring. Install blank cover plates, painted to match surrounding, at pull boxes, junction boxes and all others to which no fixture or device is to be attached.
- D. Securely fasten outlet boxes in position using clips or other suitable means. Secure boxes rigidly to the substrate upon which they are being mounted. Solidly embed boxes in concrete or masonry. Boxes shall not be permitted to move laterally, or to be supported only by EMT or conduit.
- E. Provide plaster rings for all boxes in plastered walls and ceilings.
- F. Where more than one switch occurs at the same location, use multiple gang outlet boxes covered by a single plate. Separate switches ganged in one box by a grounded metal barrier where system voltage exceeds 150 volts to ground. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductor of appropriate ampacity. Leave terminations of such jumpers exposed. Use masonry type boxes with square corners

in unplastered tile walls to allow tile to be sawed out neatly around box. Plates shall cover any cracks between box and tile. Use oversize plates where necessary.

3.1.3 LIGHTING FIXTURE BOXES

- A. Do not install boxes for suspended lighting fixtures which are attached to and supported from suspended ceilings. Coordinate all lighting fixture outlets with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation. Install approved 3/8" fixture studs in outlets from which lights are suspended, fastened through from back of box. Anchor outlet boxes and particularly those supporting fixtures, securely in place in an approved manner. Support outlet boxes and fixtures from building structures, not from ceiling material. Provide yokes, channels, studs or other supporting materials as required.
- B. At all exit luminaires installed in grid ceilings (T-grid), provide a Cooper Industries BA50F or approved equal.

3.1.4 WALL MOUNTING HEIGHT

- A. Mounting height of a wall-mounted outlet box means the height from finished floor to bottom of box.
- B. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation.
- C. Remove and relocate any outlet box placed in an unsuitable location.

3.1.5 BACK-TO-BACK BOXES

- A. Do not connect outlet boxes back to back unless prior approval from Engineer is obtained.
- B. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

3.1.6 BOX OPENINGS

- A. Provide only the openings necessary to accommodate the conduits at each individual location.

3.2 JUNCTION, PULL AND SPLICE BOXES

3.2.1 INSTALLATION

- A. Install boxes as required to facilitate cable installation in raceway systems.
- B. Provide boxes in conduit runs of more than 100 feet or as required in Division 26.
- C. Locate boxes strategically and make them of such shape to permit easy pulling of wire or cables.
- D. Locate exposed pull or junction boxes subject to the owner's representative's approval. Protect boxes in such a manner as to prevent foreign material, such as plaster, from entering boxes. Boxes shall be thoroughly cleaned of foreign materials before pulling conductors.
- E. Install and support boxes per NEC 314-23 as required and as directed.

3.2.2 COVERS

- A. Provide boxes so that covers are readily accessible and easily removable after completion of the installation.
- B. Include suitable access doors for boxes above suspended ceilings.
- C. Select a practical size for each box and cover.
- D. Label covers with permanent "black" felt-tip marker. Circuit numbers shall be provided on power covers.
- E. Spray paint fire alarm covers red.

3.3 LOCATION OF BOXES

- A. The approximate location of boxes for switches, light outlets, power outlets, etc. is indicated on the plans. These drawings, however, may not give complete and accurate information in regard to locations of such items. The exact locations shall be determined by reference to the general building plans and by actual measurements during construction of the building, subject to the Architect's approval.
- B. The Owner's representative reserves the right to make reasonable changes, up to six feet, in the indicated locations before work is roughed in, without additional charge.
- C. Unless otherwise shown or specified, install boxes for switches 44" and receptacles 18" above finished floor. Verify all door swings with the drawings and schedules and locate switches and pull stations, unless specifically noted otherwise, on the strike side of the door. If switch is indicated on hinged side of door, verify location with the Owners Representative.
- D. Where shown near doors, install wall switches shall be ganged in multiples as required covered by a single multigang cover plate. Where convenience outlets, telephone outlets, or data processing equipment outlets are near each other, outlet boxes shall be joined or otherwise placed so that they are all the same level. Device plates shall match for all outlets.

END OF SECTION

SECTION 26 05 34

PROVISIONS FOR COMMUNICATION, SECURITY AND SAFETY SYSTEMS

PART 1 GENERAL

1.1 WORK INCLUDES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.
- B. It shall be the responsibility of the Electrical Contractor to provide and install in his base proposal all conduit systems, raceways, standard electrical boxes, operating power, and other provisions for all communication, security, and safety systems as outlined in the drawings and specifications.

1.2 RELATED SECTIONS

- A. Section 26 05 26 - Grounding and Bonding For Electrical Systems
- B. Section 26 05 33.11 - Raceways and Conduits For Electrical Systems
- C. Section 26 05 33.13 - Boxes and Fittings For Electrical Systems
- D. Section 26 05 53 - Identification for Electrical Systems
- E. Division 28 - Electronic Security and Safety
- F. Any requirements for additional systems indicated by the plans and specifications.

1.3 CODES AND REGULATIONS

- A. NFPA 70, National Electrical Code.
- B. NFPA 72, National Fire Alarm and Signaling Code.
- C. NFPA 90A, Installation of Air Conditioning and Ventilation Systems.
- D. NFPA 101, Code for Safety to Life from Fire in Buildings and Structures.
- E. ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard.
- F. ANSI/EIA/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces.
- G. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
- H. ASME/ANSI A17.1 Safety Code for Elevators and Escalators
- I. Americans with Disabilities Act.
- J. Texas Accessibility Standards.
- K. International Building Codes (IBC).

- L. Local and State Building Codes.
- M. All requirements of the local Authority Having Jurisdiction (AHJ).

1.4 SUBMITTALS

- A. Submittal procedures: See Section 26 00 90.
 - 1. A submittal may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- B. Product Data:
 - 1. Drawing location all components to be supplied indicating circuit routing, cable type, and gauge.
 - 2. Product data including special boxes, cable, and other material as requested by the Architect as follows:
 - 3. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting sub-contractor. Include on or after the cover sheet sufficient space for review stamps.
 - 4. Indicate any deviations from Contract Document requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
 - 5. A product data index and complete equipment list including for each product submitted for approval the manufactures name and part number, including options and selections.
 - 6. Cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by prominent notation (an arrow, circle, or other means) on each sheet the exact product and options being submitted.
 - 7. Submit design data, when the scope of work requires, including calculations, schematics, risers, sequences, or other data.
 - 8. Submit shop or coordination drawings, when the scope of work requires, including accurate to scale device layouts, diagrams, and schedules specifically prepared to illustrate the submitted portion of work. Shop drawings shall include information to allow to the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product.
 - 9. Any resubmittal shall include a complete revised equipment list and any product data that is revised.
- C. Submit complete submittal package within 30 calendar days after award of this work for approval. Equipment is not to be ordered without approval. Partial submittals are not acceptable for review. Each submittal shall include a dated transmittal.

1.5 ELECTRICAL WIRING AND EQUIPMENT FOR COMMUNICATION, SECURITY, AND SAFETY SYSTEMS

- A. Electrical Contractor to provide in the base proposal:
 - 1. Provisions for all communications, security, and safety systems equipment (furnished under Division 26, Division 28, a Division 1 allowance, or by the Owner).
 - 2. Provide building interconnect and service entry conduit as indicated on drawings.
 - 3. Provide equipment mounting boards as indicated on drawings.
 - 4. Provide line voltage operating power outlets and direct connection to all communications, security, and safety equipment as required.
 - 5. Provide ground conductors and bonding to the building grounding system for all communications, security, and safety equipment panels and racks.
 - 6. Provide all required standard back boxes and raceways / conduit as required for cabling accessibility for devices furnished by communications, security, and safety contractors.

7. Provide full conduit for all communications, security, and safety cabling that would be exposed areas such as gyms, stages, field houses, or shop areas, and other areas as directed and as required.
8. Provide installation of special boxes and equipment cabinets furnished by communications, security, and safety contractor(s).

1.6 COMMUNICATIONS, SECURITY, AND SAFETY CONTRACTOR(S) TO PROVIDE (UNDER DIVISION 26, DIVISION 28, A DIVISION 1 ALLOWANCE, OR BY THE OWNER)

- A. Communications, security, and safety systems complete with equipment, cabling, special backboxes, hardware, and all other required devices.
- B. Furnish special boxes in timely manner to the electrical contractor for installation as required.
- C. Provide and install prior to cable installation plastic snap in bushings at each box opening, passage through a metal stud, and at the end of all open conduit stubs or sleeves to protect the cabling from damage.
- D. Attachments for all communications cable to be supported from the building structure and bundled. Coordinate raceway, power, and outlet requirements with general and electrical contractor.
- E. Attachments to support from the building structure and bundle all communications cable.
- F. Coordinate raceway, power, and outlet requirements with Builder and Electrical Contractor.
- G. Final connection to the fire alarm system of duct mounted smoke detectors. Detector housings, and control relays are to be mounted by the Division 23 Contractor.
- H. Provide all required materials, equipment, tools, scaffolding, labor, and transportation necessary for the complete installation of the communications, security, and safety systems as shown on the drawings and as specified herein.
- I. It is the intent of these specifications to provide complete installations although each item necessary is not specifically mentioned or shown.

1.7 WORK NOT INCLUDED

- A. Contractors shall make no agreement that obligates the Owner to pay any company providing communications, monitoring, or other services. Contractors shall not make selection, purchase, or installation of interconnect instruments/equipment to be used on this project.

1.8 COORDINATION

- A. Coordinate with Owner requirements, and provide accordingly.
- B. Coordinate with Division 28 Contractor requirements, and provide accordingly.

PART 2 PRODUCTS

2.1 COMMUNICATIONS, SECURITY, AND SAFETY SYSTEMS

- A. Conduit and Backboxes:
 1. Raceways will be used to route all communications cabling to accessible spaces. Conduit (metal conduit where fire rated) in attic space is required at wall penetrations, HVAC ducts,

- plenums, or other environmental air spaces (i.e. non-ducted return air ventilation systems) per NEC Article 800.
2. Conduit is required in attic space only for accessibility. Communications cabling shall be run open bundled and supported from structure by the communications, security, and safety contractor.
 3. Conduit shall be provided in through the floor sleeves for communications cable risers as indicated on plans or required.
 4. Provide 1" size conduit minimum for data and combination devices, or sized as noted or required from junction box at devices to accessible attic space.
 5. All wiring shall be enclosed in conduit in all visible or exposed areas such as gymnasiums, play areas, field houses, shop areas, platforms, or stages.
 6. All communications conduit to floor boxes shall be 1" minimum rigid conduit.
 7. All conduit, duct, track, and raceway runs shall be spaced apart to allow for maintenance, such as the installation of couplings, without disturbing adjacent pathways.

2.2 FIRE DETECTION AND ALARM SYSTEM

- A. The Electrical Contractor shall provide 120-volt power as required to fire alarm system through separate dedicated branch circuits, maximum 20 amperes. The fire alarm control panel (FACP), digital communicator (DC), and the signal power expanders (SPX) combine to form the fire alarm control unit. The FACP, DC, and a SPX, or two or more SPXs, etc. may be fed from one circuit as long the amperage drawn is within the limitations of a 20-ampere circuit. Each such circuit breaker shall be labeled in red at the power distribution panel as FIRE ALARM. A breaker panel key shall be stored within the locked cabinet of each fire alarm control unit. The location of all circuit breakers serving the fire alarm control unit shall be posted in the fire alarm control unit cabinets. Each cabinet shall be grounded securely to the building grounding system.
- B. Line voltage, 120 VAC, fire safety control circuits shall in all cases be of "fail safe" operation and shall not have backup power. On activation of the fire alarm, or loss of power, all connected devices shall actuate to their fire safety condition (i.e. HVAC blower control relays shall open, smoke fire dampers shall close, and fire door holders shall release). These circuits shall be controlled by a power relay located within three feet of the breaker panel. Control relays shall be located within three feet of the unit controlled. The power relay shall feature properly rated electrical contacts for a 120 VAC, 20-ampere circuit. These circuits shall be switched by a power relay controlled by the fire alarm system and wired by the Electrical Contractor. Line voltage control circuits shall be standard non-supervised line voltage circuits in conduit, with the same type of conductors as specified in Division 26 for light and power circuits.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide only materials that are new, of the type and quality specified.
- B. Coordinate with and provide all Owner requirements.
- C. Cabinets and backboxes are to be level and square to wall.
- D. Conduit and cable support systems shall be complete with bushings, de-burred, cleaned, and secure prior to installation of cable.

- E. Wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts.
- F. Permanently mark all cables and install in a professional, neat, and orderly installation.

3.2 DRAWINGS

- A. All cables shall have both ends labeled and included in the as built documentation.
- B. All cable or conduit paths and wiring methodology shall be documented.

3.3 WARRANTY

- A. The contractor shall provide a warranty of the installed equipment against defects in material or workmanship for a period of one (1) year from the date of substantial completion. Any equipment or wiring shown to be defective shall be replaced, repaired, or adjusted free of charge. All labor and materials shall be provided at no expense to the Owner.
- B. All equipment will carry a one year warranty or manufacturer's warranty whichever is greater.

END SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

- A. Identification required for electrical systems.
- B. Code required identification not shown on plans nor specified herein shall be provided.

1.1.2 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Division 26, Section 26 00 00, apply to this Section.
- B. See the following sections for related work.
 - 1. Section 26 00 00 - Electrical
 - 2. Section 26 00 90 - Electrical Submittal Procedures
 - 3. Section 26 21 00 - Low Voltage Electrical Service Entrance
 - 4. Section 26 24 16 - Panelboards For Distribution Switchgear
 - 5. Section 26 28 16 - Enclosed Safety Switches and Circuit Breakers

1.2 SUBMITTALS

1.2.1 PRODUCT DATA

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.
- B. Submit product data for sign materials. Refer to Electrical Identification detail on drawings for additional information.

1.2.2 QUALITY ASSURANCE/CONTROL SUBMITTALS

- A. After the owner's room number list is finalized, submit a list of all electrical identification tags. The list shall include the actual text that will appear on each tag. Include the owner's and architects room numbers on all tags. This list shall be submitted for the review of the owner and architect.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Sign Materials:
 - 1. Type:
 - a. Engraving-Stock
 - b. Melamine plastic laminate
 - 2. Thickness:
 - a. Less than 25 square inches:
 - (1) 1/16 inch

- b. 25 square inches or more:
 - (1) 1/8 inch
 - 3. Color: Black Conform to FS L-P-287
- B. Lettering:
- 1. Style: Engraved standard print, unless otherwise indicated.
 - 2. Size: 3/16 inch to 1/4 inch
 - 3. Color: White

2.2 SIGN INFORMATION:

- A. Panelboard (New):
- 1. Data:
 - a. Panelboard designation
 - b. Voltage, phase and wires
 - c. Source of service
 - 2. Example:
 - a. CHAC
 - b. 277/480V., 3-phase, 4-wire
 - c. fed from MDP
- B. Switchboard:
- 1. Data:
 - a. Switchboard designation
 - b. Source of service
 - c. Panel type
 - d. Style
 - e. Amperage
 - f. Neutral amperage
 - g. Voltage of each branch circuit designation.
 - h. Phase and wires.
 - 2. Example:
 - a. DPC – 277/480V.
 - b. 3 phase
 - c. 4 wire
 - d. fed from MDP
- C. Safety Switches:
- 1. Data:
 - a. Switch or load served designation.
 - b. Voltage and phase.
 - 2. Example: In the following example, the text in parenthesis does not go on the actual tag. It is for clarification only.
 - a. #112 (Owner's Room Number)
 - b. A/C #C206 (Architect's Room Number)
 - c. Circ. CHAC-15
 - d. 480V.
 - e. 3 phase
- D. Time Clocks:
- 1. Data:
 - a. Time clock load(s) served
 - b. Voltage and phase
 - c. Source of service
 - 2. Examples:
 - a. Parking Lot Lights

- b. 480V.
 - c. Single Phase
 - d. Fed from CH-15
- E. Soffit Lights
 - 1. 277V.
 - 2. Fed from CH-21
- F. Water Heater:
 - 1. 208V.
 - 2. Single phase
 - 3. Fed from AL2-25
- G. Electrical Riser Diagram Signs:
 - 1. Material:
 - a. Provide laminated copy of electrical riser diagram and screw to wall in each electrical room.
 - 2. Size:
 - a. Minimum: 12" x 17"
 - b. Maximum: 30" x 42"
 - 3. Provide a riser diagram in each electrical room similar to the riser diagram shown on the plans, and/or as required for the area served.
- H. Device Engraving:
 - 1. Any switch for load that is not in sight of the equipment served: custom engrave on outside of switch cover plate.
 - 2. Custom engrave switch function when called for on the plans.
- I. Panelboard Directory:
 - 1. For each panelboard, provide a directory-frame mounted inside the door with heat-resistant transparent face and a directory card for identifying the load served.
 - 2. Identify circuits by equipment served on by room numbers where room numbers exist. Room numbers shall be as directed by Owner.
 - 3. Verify nomenclature at job site.
 - 4. Directory shall be typed, shall coordinate with panel breaker and be neat.
 - 5. Indicate spares and spaces with erasable pencil.
- J. Refer to Section 26 24 16 (Panelboards for Distribution Switchgear) and Section 26 21 00 (Low Voltage Electrical Service Entrance).
- K. Nameplate Fasteners:
 - 1. Securely attach nameplates to equipment with non-corroding stainless steel screws.
 - 2. Non-corroding pop rivets are acceptable.
 - 3. Stick-ons or adhesives will not be allowed.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate with the architect to obtain a list of the finalized owner's room number list.
- B. Prepare the quality control submittal of tag data as described in the Submittals article of this specification.

- C. After the submittal has been reviewed without comment by the architect and the owner, proceed to order the identification tags.
- D. Tags with incorrect data that have not been reviewed without comment by the architect and owner do not comply with these specifications.

3.2 INSTALLATION

- A. Provide signs for equipment requiring identification as shown on drawings and for equipment as required by National Electric Code.
- B. Provide for each main disconnect not grouped together.
- C. Refer to Section 26 28 16 for Enclosed Safety Switches and Circuit Breakers.
- D. Install signs on outside of cover for safety switches and time clocks.
- E. Install signs on outside top, not on door, and at each circuit for panelboards, switchboards and motor control centers.
- F. Label spares and blank spares in light, erasable pencil.
- G. Mount in an easily visible location.
- H. All labeling identification shall contain both the owner's and architect's room names and numbers. Coordinate with General Contractor to secure construction room numbers.
- I. Provide all additional signage required by local authority at no cost to the Owner.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Commissioning:
1. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - a. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - b. Verify and document proper performance of equipment and systems.
 - c. Verify that O&M documentation is complete.
 - d. Verify that the Owner's operating personnel are adequately trained
 2. The systems to be commissioned include: electrical switchgear and panels, emergency power systems (if included), UPS Systems (if included), electrical and lighting controls, fire alarm system, and life safety systems and controls.
 3. Commissioning requires the participation of affected Division contractors to ensure that all systems are operating in a manner consistent with the Contract Documents. All affected Division contractors shall be familiar with all parts of the commissioning plan issued by the CA (Commissioning Authority) and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
 4. Commissioning Team:
 - a. The members of the commissioning team consist of the Commissioning Authority (CA), the designated representative of the owner, the General Contractor (GC or Contractor), the Architect and Design Engineers, the Mechanical Contractor (MC), the Electrical Contractor (EC), the Controls Contractor (CC), the Fire Alarm Contractor, and any other installing subcontractors or suppliers of equipment. The Owner's building or plant operator/engineer is also a member of the commissioning team.

1.2 COMMISSIONING AUTHORITY

- A. The commissioning authority and/or agency shall be selected and employed by the building owner. The commissioning agent shall be a licensed professional engineer in the State where the work will be performed, and shall be experienced in the commissioning of mechanical and electrical systems of the type installed in this project. Experience in construction process, direct digital control systems, test and balance and ASHRAE Guideline 1 – 1998 is mandatory. The commissioning agent shall not be associated with or employed by a mechanical contractor, or equipment supplier.

1.3 COMMISSIONING PLAN:

- A. Commissioning Plan:
1. The commissioning plan provides guidance in the execution of the commissioning process. Just after the initial commissioning scoping meeting the CA will provide the plan, which will continue to evolve and expand as the project progresses. The Specifications will take precedence over the Commissioning Plan.

B. Commissioning Process:

1. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
2. Commissioning during construction begins with a scoping meeting conducted by the CA where the commissioning process is reviewed with the commissioning team members.
3. Additional meetings will be required throughout construction, scheduled by the CA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems. Generally, these meetings will be included with or will be sequential with regular subcontractor meetings.
4. Equipment documentation is submitted to the CA during normal submittals, including detailed start-up procedures.
5. The CA works with the Subs in developing startup plans and startup documentation formats, including prefunctional checklists to be completed, during the startup process.
6. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
7. The Subcontractors, under their own direction, execute and document the prefunctional checklists and perform startup and initial checkout. The CA documents that the checklists and startup were completed according to the approved plans. This may include the CA witnessing start-up of selected equipment and systems.
8. The installing contractors, suppliers and manufacturers, develops specific equipment and system functional performance test procedures with the assistance of the CA.
9. The procedures are executed by the Subcontractors, under the direction of, and documented by the CA.
10. Items of non-compliance in material, installation or setup are corrected at the Subcontractor's expense and the system retested.
11. The CA reviews the O&M documentation for completeness. All O&M documentation must be submitted and approved before the start of training.
12. Commissioning shall be completed before Substantial Completion.
13. The CA reviews, pre-approves and coordinates the training provided by the Subs and verifies that it was completed.
14. Deferred testing is conducted, as specified or required.

1.4 RESPONSIBILITIES

A. General Contractor (GC):

1. Facilitate the coordination of the commissioning work by the CA, and with the CA ensure that commissioning activities are being scheduled into the master schedule.
2. Include the cost of commissioning in the contract price.
3. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA.
4. In each purchase order or subcontract written, include requirements for submittal data, Systems/O&M data, commissioning tasks and training.
5. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
6. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the CA to facilitate the Commissioning process.
7. Coordinate the training of owner personnel.
8. Prepare Systems/O&M manuals and Systems manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

B. Warranty Period:

1. Ensure that Subcontractors execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

2. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- C. Electrical Contractors and Sub-Contractors:
1. The commissioning responsibilities applicable to each of the subcontractors are generally as follows (all references apply to commissioned equipment only). Specific requirements are shown in the appropriate Divisions.
 2. Construction and Acceptance Phases
 - a. Include the cost of commissioning in the contract price.
 - b. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, Systems/O&M data and training.
 - c. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Commissioning process.
 - d. Contractors shall provide the CA with normal cut sheets and shop drawing submittals of commissioned equipment as part of the normal submittal process.
 - e. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.
 - (1) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
 - (2) The Commissioning Authority may request further documentation necessary for the commissioning process.
 - f. Provide a copy of the Systems/O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.
 - g. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - h. Provide assistance to the CA in preparing the specific functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 - i. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the CA for all commissioned equipment. Submit to CA for review and approval prior to startup.
 - j. During the startup and initial checkout process, execute the prefunctional checklists for all commissioned equipment.
 - k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
 - l. Address current A/E punch list items before functional testing
 - m. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
 - n. Perform functional performance testing under the direction of the CA for specified equipment. Assist the CA in interpreting the monitoring data, as necessary.
 - o. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, and A/E and retest the equipment.
 - p. Prepare Systems/O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

- q. Prepare redline as-built drawings for all drawings and final as-builds for contractor-generated coordination drawings.
 - r. Provide training of the Owner's operating personnel as specified.
 - s. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- D. Warranty Period:
- 1. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
 - 2. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- E. Equipment Suppliers:
- 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 - 2. Assist in equipment testing per agreements with Subs.
 - 3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CA.
 - 4. Provide information requested by CA regarding equipment sequence of operation and testing procedures.
 - 5. Review test procedures for equipment installed by factory representatives.
- F. Commissioning Authority (CA):
- 1. The CA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CA is to develop and coordinate the execution of a testing plan, observe and document performance - that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, checkout and functionally test equipment and systems, except for specified testing equipment supplied and installed by the CA.
 - a. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
 - b. Coordinate the commissioning work and, with the GC, ensure that commissioning activities are being scheduled into the master schedule.
 - c. Revise, as necessary, Commissioning Plan—Construction Phase.
 - d. Plan and conduct a commissioning scoping meeting.
 - e. Request and review additional information required to perform commissioning tasks, including Systems/O&M materials, contractor start-up and checkout procedures.
 - f. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
 - g. Review and approve normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, along with A/E reviews.
 - h. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
 - i. Approve pre-functional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.

- j. Approve systems startup by reviewing start-up reports and by selected site observation.
 - k. Review the functional performance test procedures for equipment and systems developed by the subcontractors and suppliers. This may include energy management control system trending, or manual functional testing.
 - l. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
 - m. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
 - n. Oversee and approve the training of the Owner's operating personnel.
 - o. Compile and maintain a commissioning record.
 - p. Review and approve the preparation of the Systems/O&M manuals.
 - q. Provide a final commissioning report.
- G. Warranty Period:
- 1. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
 - 2. Return to the site at 10 months into the 12-month warranty period and review with facility staff the current building operation and the condition of outstanding issues. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the Systems/O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.
- H. Scheduling:
- 1. The CA will work with the GC according to established protocols to schedule the commissioning activities. The CA will provide sufficient notice to the CM and GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division contractor for the equipment being tested
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications

PART 3 EXECUTION

3.1 MEETINGS

- A. Scoping Meeting:
 - 1. Within 90 days of commencement of construction, the CA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the GC. Information gathered from this meeting will allow the CA to revise the Commissioning Plan to its “final” version, which will also be distributed to all parties.
- B. Miscellaneous Meetings:
 - 1. Other meetings will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular subs. The CA will plan these meetings and will minimize unnecessary time being spent by Subs.

3.2 REPORTING

- A. The CA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.
- B. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.
- C. A final summary report by the CA will be provided focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report.

3.3 SUBMITTALS

- A. The CA will provide appropriate contractors with a specific request for the type of submittal documentation the CA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, Systems/O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority. All documentation requested by the CA will be included by the Subs in their Systems/O&M manual contributions.
- B. The Commissioning Authority will review and approve submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning Agent will notify the appropriate persons as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.
- C. The CA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.

3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned. Some systems that are not comprised so much of actual dynamic machinery may have very simplified PCs and startup.
- B. General:
 - 1. Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Start-up and Initial Checkout Plan:
 - 1. The CA shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. Parties responsible for executing functional performance tests are identified in the testing requirements.
 - a. The CA assist in the development of checklists that indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
 - b. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form may have more than one trade responsible for its execution.
 - c. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CA's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - d. The full start-up plan could consist of something as simple as:
 - (1) The contractor and CA prefunctional checklists.
 - (2) The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - (3) The manufacturer's normally used field checkout sheets.
 - e. The subcontractor submits the full startup plan to the CA for review and approval.
 - f. The CA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
 - g. The full start-up procedures and the approval form may be provided to the CM for review and approval, depending on management protocol.
- D. Execution of Prefunctional Checklists and Startup:
 - 1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the GC and CA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
 - 2. The CA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as approved).

3. For lower-level components of equipment the CA shall observe a sampling of the prefunctional and start-up procedures.
 4. The Subs and vendors shall execute startup and provide the CA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
 5. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off.
- E. Deficiencies, Non-Conformance and Approval in Checklists and Startup:
1. The Subcontractors shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CA within two days of test completion.
 2. The CA shall work with the Subcontractors and vendors to correct and retest deficiencies or uncompleted items. The CA will involve the CM or GC and others as necessary. The installing Subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CA recommends approval of the execution of the checklists and startup of each system using a standard form.

3.5 FUNCTIONAL TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
1. Objectives and Scope:
 - a. The objective of functional testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
 - b. In general, each system should be operated through all modes of operation where there is a specified system response. Verifying each sequence in the sequences of operation is required.
 2. Development of Test Procedures:
 - a. Before test procedures are written, the CA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Each Sub or vendor responsible to execute a test, shall provide assistance to the CA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CA may submit the tests to the A/E for review, if requested.
 - b. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.
 3. Test Methods:
 - a. Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results. The CA will determine which method is most appropriate for tests that do not have a method specified.
 4. Coordination and Scheduling:
 - a. The Subs shall provide sufficient notice to the CA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CA will schedule functional tests through the GC and affected Subcontractors. The CA shall direct, witness and document the functional testing of all equipment

and systems. The Subs shall execute the tests.

- b. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation:

1. The CA shall witness and document the results of all functional tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the GC for review and approval and to the Subs for review. The CA will include the filled out forms in the Commissioning Report.

B. Non-Conformance:

1. The CA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported on a standard non-compliance form.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.
4. As tests progress and a deficiency is identified, the CA discusses the issue with the executing contractor.
 - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
 - (1) The CA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - (2) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the GC and to the Subcontractor representative assumed to be responsible.
 - (3) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.
 - (4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The CA reschedules the test and the test is repeated until satisfactory performance is achieved.

C. Cost of Retesting:

1. The cost for the Subcontractor to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
2. The Contractor shall respond in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
3. The CA retains the original non-conformance forms until the end of the project.

D. Failure Due to Manufacturer Defect:

1. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted

performance spec, all identical units may be considered unacceptable. In such case, the Contractor shall provide the Owner with the following:

- a. Within one week of notification, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided within two weeks of the original notice.
- b. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
- c. The Owner will determine whether a replacement of all identical units or a repair is acceptable.
- d. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

E. Approval:

1. The CA notes each satisfactorily demonstrated function on the test form. The CA recommends acceptance of each test using a standard form. The Owner gives final approval on each test using the same form, providing a signed copy to the CA and the Contractor.

3.7 SYSTEMS/OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following Systems/O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.
- B. Each Division shall compile and prepare documentation for all equipment and systems covered in that Division and deliver this documentation to the GC for inclusion in the Systems/O&M manuals, according to this section, prior to the training of owner personnel.
- C. The CA shall receive a copy of the O&M manuals for review.
- D. Field checkout sheets and logs should be provided to the CA for inclusion in the Commissioning Record Book.
- E. Review and Approvals:
 1. Review of the commissioning related sections of the Systems/O&M manuals shall be made by the A/E and by the CA.

3.8 TRAINING OF OWNER PERSONNEL

- A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.
- B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

3.9 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the start-up and initial checkout plan described and the filled out start-up, initial checkout and prefunctional checklists, manufacturer's factory and field testing and inspection forms, contractors' inspection and functional testing forms, Systems/O&M Manuals, /training plans and training records.

- B. These work products will be supplied to the CA to be included in the final commissioning report.

END OF SECTION

SECTION 26 08 11

TESTING OF ELECTRICAL SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Complete testing and evaluations to assure that the electrical system is installed for proper operation.

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- D. Section 26 27 26 - Wiring Devices

1.4 REFERENCES

- A. Biddle Instruments #21-P8a - Electrical Insulation Testing
- B. Biddle Instruments #25Ta - Earth Resistance Testing

1.5 COORDINATION

- A. Coordinate special tests and/or equipment start-up as specified or implied in related sections.

1.6 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements. Included in this section are megger tests of all main feeders to all switchboards and/or panelboards. Submit tests of insulation resistance, conductor resistance, and ground resistance.

PART 2 PRODUCTS

- A. Not used.

PART 3 EXECUTION

3.1 TESTING

- A. Perform in accordance with manufacturer's printed testing procedures, applicable industry standards, ANSI standards, IEEE standards, NEMA standards and as directed by the

Engineer. Provide testing equipment in good working order and which complies with the applicable industry standards and manufacturer's requirements. Include a list of testing equipment used and date of last calibration.

- B. Test the following:
 - 1. Feeder conductors to main switchboard.
 - 2. Feeder conductors from switchboard to panelboards.
 - 3. Grounding means for all switchgear.
 - 4. Grounding of the Electrical system neutral: Ground resistance shall not exceed 10 ohms.
 - 5. Equipment grounds for each feeder: Ground resistance shall not exceed 25 ohms.
 - 6. Grounds for each transformer: Ground resistance shall not exceed 25 ohms.
 - 7. Insulation resistance: Ground resistance shall not be less than one (1) megohm.
- C. Perform all tests in the presence of the Engineer, Architect or the Owner in accordance with the forms included in this section.
- D. Submit each test form within ten (10) working days from the time the test is performed.
- E. Document all test results and provide a signed report by the testing technician as witnessed. Reports shall include date, time, weather conditions, field conditions, test data, instruments used and brief description of the test. Include reports in operating manuals. Submit tests.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

Insulation Test Results (Megger)

Feeder Description	Test Date	Resistance (megohms)	Remarks

Notes:

1. Test shall be conducted after conductors are pulled.
2. Ground resistance on insulation shall be no less than one (1) megohm.
3. Make copies of this form if more blanks are needed.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

Transformer Test Results

Transformer	Test Date	Secondary Voltage	Tap Setting	Grounding of Transformer Neutral (ohms)	Remarks

Notes:

1. Test on transformer neutral and tap settings shall be performed at time of substantial completion.
2. Ground resistance of transformer neutral shall be no greater than ten (10) ohms.
3. Make copies of this form if more blanks are needed.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

Feeder Ground Test Results

Feeder	Test Date	Resistance (ohms)	Remarks

Notes:

1. Test shall be conducted at time of substantial completion.
2. Ground resistance shall not exceed 25 ohms.
3. Make copies of this form if more blanks are needed.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

System Neutral Ground Test Results

Feeder	Test Date	Unbonded resistance (megohms) see note 1	Bonded resistance (ohms) see note 2	Remarks

Notes:

1. Neutral is not bonded to equipment and/or ground at any location. Resistance shall not be less than one (1) megohm.
2. Neutral is connected to ground at transformer only. Resistance shall not exceed 25 ohms.
3. Test shall be performed at time of substantial completion.
4. Make copies of this form if more blanks are needed.

END OF SECTION

SECTION 26 09 13

ELECTRICAL POWER MONITORING AND CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Switchboard instrumentation where shown on the plans.
- B. Switchboards 1,000 amps and larger.

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 24 16 - Panelboards For Distribution Switchgear

1.4 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.
- B. Manufacturers printed statement of accuracy. Color cut sheets of meter with all accessories to be used.
- C. Wiring diagram of meters and current transformers.

PART 2 PRODUCTS

2.1 TYPE

- A. Microprocessor based monitoring meter to provide monitoring functions as well as deliver inputs to HVAC controller.

2.2 MONITOR PERFORMANCE CRITERIA

2.2.1 ACCURACY OF READINGS

- A. AC Ampere: $\pm 0.5\%$
 - 1. Phase A
 - 2. Phase B
 - 3. Phase C
- B. AC Voltage: $\pm 0.5\%$
 - 1. Phase A-B
 - 2. Phase B-C
 - 3. Phase C-A
 - 4. Phase A - Neutral

- 5. Phase B - Neutral
- 6. Phase C - Neutral
- C. Watts: $\pm 1\%$
- D. VARS: $\pm 1\%$
- E. Power Factor: $\pm 1\%$
- F. Frequency: $\pm 0.5\%$
- G. Watt Demand: $\pm 1\%$
- H. Watt Hours: $\pm 1\%$

2.3 FEATURES

- A. Communication port for building energy management system hook-up.

2.3.1 TRANSFORMERS

- A. Current Transformers: 100/5 through 5,000/5
- B. Potential Transformers:
 - 1. Up to 600 Volts: Self-contained.
 - 2. Above 600 Volts: Inputs to 14.4 KV.
- C. Ratios field settable with DIP switches.

2.3.2 FIELD SETTABLE PROTECTIVE FUNCTIONS WITH ALARM OUTPUTS

- A. Voltage - Phase Loss: Occurs if less than 50% of nominal line voltage is detected.
- B. Current - Phase Loss: Occurs if smallest phase current is less than 1/16 of the largest phase current.
- C. Phase Unbalance: Occurs if the maximum deviation between any two phases exceeds the amount of unbalance as a percent of nominal line voltage preset by DIP switches.
- D. Range: 5 to 40% (5% increments).
- E. Phase Reversal: Occurs if any two phases become reversed for more than one second.
- F. Overvoltage: Dip switch setting of percent of nominal line volts.
- G. Range: 105 to 140% (5% increments).
- H. Undervoltage: DIP switch setting of percent of nominal line volts.
- I. Range: 95% to 60% (5% increments).
- J. Delay: Allows existence of overvoltage, undervoltage, or voltage unbalance before an alarm or trip occurs.
- K. Range: 0-8 sec. (1 sec. increment).

- L. Percent Trip Level and Trip Time Interval: Field settable.

2.3.3 SIMPLE ELECTRICAL CONNECTIONS

- A. Same as a watt meter.
- B. 50/60 cycle, 3 or 4 wire systems.
- C. Self-protected from fault.
- D. Updated Data Response every 1.08 seconds. Unit shall be user friendly.
- E. Replaces ampmeter, voltmeter, watt meter, selector switch, etc.
- F. Only CT and PT hook-up required to a single device.
- G. No separate potential source required.
- H. Active or inactive protection relaying.
- I. Interface capability to computer network for data collection.
- J. Storage and/or print-out via INCOM.
- K. Retains preset parameters in case of a power failure with use of filled settable DIP switches (no batteries).
- L. Separate alarm and trip relay outputs.
- M. Energy Management features include kilowatt, power factors, demand kilovars, and pulse initiator with each meter. Provide one system per service entrance, main and/or grouped mains.

2.4 CONSTRUCTION

- A. 4.5 inches deep.
- B. Door mounted.
- C. Panel shall be designed for a harsh industrial environment, and be UL recognized.
- D. Main Service Metering
 - 1. Square D Power Logic PM 710 with integrated display.
- E. Equal meters accepted by:
 - 1. General Electric
 - 2. Eaton Corporation (formerly Cutler-Hammer)
 - 3. Siemens

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install meters so as to be easily removed.
- B. Provide all fuse blocks and terminal strips as required.
- C. Run 3/4 inch conduit to energy management control system (EMCS) panel. Engineer to decide final location. Provide 120V hook-up to EMCS panel. All control wiring in accordance with other Divisions 1, 23, 25, and 27.

END OF SECTION

SECTION 26 09 16

TIME SWITCHES

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

- A. Time switches for lighting control.
- B. Time switches for circulating pumps.

1.1.2 RELATED SECTIONS

- A. Section 26 00 00 – Electrical
- B. Section 26 00 90 – Electrical Submittal Procedures
- C. Section 26 05 53 – Electrical Identification
- D. Section 26 28 16 – Enclosed Safety Switches and Circuit Breakers

1.2 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.
- B. Product Data: Submit product data for time switches.
- C. Samples: Provide a non-returnable sample when requested.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Water Heater Time Clocks & Batteries:
 - 1. Tork Model EH10/20 Digital Control Clock
 - 2. Battery Backup - 9V lithium
 - a. Paragon Model EC4004P
- B. All other manufacturers shall require pre-approval in accordance with specification section 26 00 90 – Electrical Submittal Procedures.

2.2 MATERIALS

- A. Case:
 - 1. Indoor/outdoor Nema 3R enclosure. Self-extinguishing high impact plastic.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install near the panelboard supplying service to lighting load per manufacturer's direction.
- B. Mount time switch not more than 12" above top of switchgear and so that the time switch is readily accessible.
- C. Programming:
 - 1. Program the time switches as directed. Include programming and operating instructions in "Records for Owner" as outlined in Section 26 00 00.
 - 2. Instruct the Engineer in setting the switches before final inspection.
- D. Label Time Clock.

3.2 WATER HEATER TIME CLOCKS

- A. Provide a Digital Control Clock for each water heater. Located time clock in electrical room and label "Water Heater - (Location)".
- B. Set to Operate:
 - 1. On: 7:00 a.m.
 - 2. Off: 11:00 a.m.
 - 3. On: 2:00 p.m.
 - 4. Off: 6:00 p.m.
 - 5. Off: Saturdays and Sundays
- C. Provide battery backup - 9V lithium
- D. Timer to control both the water heater and any circulating pump. Circulating pump to run continuously as long as water heater is operational. When the water heater is intentionally turned off to conserve energy, then turn off the circulating pump.
- E. Provide mechanically held contactor for each water heater circulating pump.
- F. Provide a non-fused disconnect at each water heater. Refer to Section 26 28 16 for Enclosed Safety Switches and Circuit Breakers.

END OF SECTION

SECTION 26 09 19

LABORATORY UTILITY SHUT-OFF SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.
- B. Furnishing and installation of Laboratory Utility Shut-Off Systems as shown on the Drawings, Details, and as herein specified.
- C. Provide all equipment, materials, labor, supervision, test equipment, and services necessary for or incidental to the installation of complete and operating laboratory utility shut-off systems installed to commercial standards. Equipment shall be provided and installed as shown or indicated on the drawings and as specified.
- D. Equipment specified herein is designed to provide specific functional and operational characteristics. It is the responsibility of the laboratory utility shut-off systems Contractor to provide all features and functions as outlined in these specifications.
- E. The location of switch panels, control panels, solenoid enclosures, and other components shall be coordinated between the mechanical, electrical, plumbing contractors and the fixture providers prior to the installation of conduit or piping.
- F. Provide 120 VAC power as required to the laboratory utility shut-off system at each Utility Control Panel Enclosure, through individual dedicated branch circuits maximum 20 amperes each. Several Utility Control Panel Enclosure systems may be fed from one circuit as long the amperage drawn is within the limitations of a 20-ampere circuit. The branch circuit shall not be supplied through ground-fault circuit interrupters or arc-fault circuit interrupters. Each such circuit breaker shall be labeled in a visible area utilizing a self-laminating, flexible vinyl film, non-smear, machine printed label, at the power distribution panel as LAB SHUT-OFF and include a surge protection module (see next item) in each circuit. Each enclosure shall be grounded securely to the building grounding system.
- G. Provide each 120 VAC power circuit with an electrical surge protection module. Each power circuit surge protector module shall be mounted in a standard metallic electric box that is grounded. Module shall be hardwired in the incoming power circuit and 20 amp rated. Units shall provide surge protection (UL 1449 3rd edition listed), noise filtering (UL 1283 listed), and nanosecond reaction three-stage MOV line protection. Shall be Ditek DTK-120SRD or equivalent.
- H. Conduct testing, as described in Part 3, for all requirements shall be performed with all wiring and devices in place.
- I. Provide all documentation and training as outlined in these specifications.

1.2 RELATED SECTIONS

- A. Section 26 00 00 – Electrical
- B. Section 26 00 30 – Warranty

1.3 SUBMITTALS

- A. Submittal procedures: See Section 26 00 90.
 - 1. A submittal may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- B. Product Data:
 - 1. Drawing locating all components of the laboratory utility shut-off systems, indicating circuit routing, cable type, and gauge.
 - 2. A sample of a system schematic drawing, a copy of this drawing shall be attached to the inside cover of each control panel enclosure for service purposes.
 - 3. Product data including special boxes, cable, and other material as requested by the Architect as follows:
 - a. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting sub-contractor. Include on or after the cover sheet sufficient space for review stamps.
 - b. Indicate any deviations from Contract Document requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
 - c. A product data index and complete equipment list including for each product submitted for approval the manufactures name and part number, including options and selections.
 - d. Cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by prominent notation (an arrow, circle, or other means) on each sheet the exact product and options being submitted.
 - e. Submit design data, when the scope of work requires, including calculations, schematics, risers, sequences, or other data.
 - f. Submit shop or coordination drawings, including accurate to scale device layouts, diagrams, and schedules specifically prepared to illustrate the submitted portion of work. Shop drawings shall include information to allow to the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product.
 - g. Any resubmittal shall include a complete revised equipment list and any product data that is revised.
- C. Submit complete submittal package within 30 calendar days after award of this work for approval. Equipment is not to be ordered without approval. Partial submittals are not acceptable for review. Each submittal shall include a dated transmittal.

1.4 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. UL 429 - Electrically Operated Valves
- C. UL 508-A - Safety Standard for Industrial Control Equipment.
- D. Guide YIOZ, File MP618, Safety Valves.
- E. FM Approved to Class 7400 "Liquid and Gas Safety Shutoff Valves".
- F. All devices provided shall be listed and labeled by Underwriters Laboratories, Inc. for the intended use under the latest appropriate testing standard.

- G. Americans with Disabilities Act.
- H. Texas Accessibility Standards.
- I. International Building Codes (IBC).
- J. TEA Science Facilities Standards, Kindergarten through Grade 12, Page 68 Emergency Shut-Off Control.
- K. Local and State Building Codes.
- L. All requirements of the local authority having jurisdiction.

1.5 SYSTEM REQUIREMENTS

- A. Provide as indicated an emergency shut-off mushroom button switch that deactivates the utility services and devices including water and electrical outlets within the classroom, laboratory room, or preparation room.
- B. The teacher shall control when these utilities are available for use by the students and, in the event of an emergency, press a single control switch to shut-off all utilities: (water, and electricity) before evacuating the room. A switch panel containing non-emergency controls for these utilities shall also be provided. A keyed switch shall restrict unauthorized activation of these services and provide for reset after an emergency shutdown. Each activated emergency shut-off mushroom button shall also require a key to restore services after an emergency shutdown.
- C. Emergency shut-off switches shall be located to be quickly accessible to the teacher (preferably near the teacher's station) and somewhat protected from nuisance use by students (preferably not at the door entry or in a hallway). All controls are to be clearly labeled.
- D. In the event of an emergency, before evacuating the room, the teacher may activate a single mushroom switch in the area, which will shut-off the area utilities and activate the area purge exhaust fan for a duration of one hour.
- E. The wall mount emergency shut-off mushroom switch shall perform all control switch panel functions at once for all the systems within the area of each individual room. Power to all designated electrical outlets shall be shut down by the Emergency Shut-Off mushroom switch per TEA requirements. Power to the designated laboratory use student station and demonstration station electrical outlets shall be controlled by utility switches for the system programmed duration in the same manner as the other utilities. All non-lab station use electrical outlets, as designated, including computer and general purpose outlets (Additional Area Receptacles) shall be shut down and restored only by an Emergency Shut-Off mushroom switch. The no-lab station use electrical outlets (Additional Area Receptacles) in the room shall not be shut-off by a system timer or by the utility control switches.
- F. Each day of laboratory utility use, the teacher may turn the control panel keyed switch to the ENABLE position and remove the key, which allows for selectively switched use of laboratory utilities for a duration of 10-hours. The utilities may be disabled at any time by turning the reset key switch to the OFF position. Note that if the reset key switch was left in the ENABLE position, and the 10-hour duration has expired, the key must be turned momentarily to OFF and then back to ENABLE to restart the 10-hour system timer.
- G. The purge fan switch shall be active regardless of control panel condition (off or enabled) and shall run the area purge fan for duration of 1-hour or until switched off. If the purge fan switch

was left in the ON position and the time has expired, the timer may be reset by switching the fan switch off and back on.

- H. Emergency Shut-Off mushroom switches shall perform the following functions:
 - 1. Shut-off all area switch controlled utilities, including the designated lab use electrical outlets in the area.
 - 2. Shut-off the general purpose and computer electrical outlets (Additional Area Receptacles) in the area.
 - 3. Run the area purge fan for a duration of 1-hour.
- I. Operation of any emergency shut-off mushroom switch shall require a key to reset at that switch. Operation of the emergency shut-off function shall also require a key reset of the control panel switch. The teacher shall be able to remain in the room to do so and no electric breakers shall require switching.

1.6 SYSTEM CONFIGURATION

- A. Each manual switch panel shown on the plans and herein specified shall be clearly labeled as shown on the plan details (STUDENT LAB STATIONS / DEMONSTRATION STATION or PREPARATORY ROOM) systems shall operate as an independent control system for the function required in the area.
- B. If the system requires step down low voltage transformers for a complete and functional system. Any transformers shall be mounted in a suitable location within a metal enclosure as described below and shall accept 120 VAC primary input and output low voltage at the amperage required by the system.
- C. Provide enclosures as required for each set of control circuits, relays, solenoids, or contractors. Size enclosures as required, with hinged door. Mount enclosures in a service accessible area located above drop ceilings as indicated on plans, or as required.
- D. All low voltage wiring shall be 18 AWG minimum.
- E. Where systems include domestic hot and cold water shut-off, a single output circuit shall control these systems simultaneously.
- F. Each utility service and purge fan system shall be independently controlled by area and shall not be combined with other areas.
- G. Follow the manufactures recommendations for the installation of each device.
- H. Exposed conduit or piping will not be permitted in the finished job.

1.7 SUBMITTALS

- A. The submittal required for this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.
- B. A submittal may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- C. Product Data:
 - 1. Drawing locating all components of the laboratory utility shut-off systems, indicating circuit routing, cable type, and gauge.

2. A sample of a system schematic drawing, a copy of this drawing shall be attached to the inside cover of each control panel enclosure for service purposes.
3. Product data including special boxes, cable, and other material as requested by the Architect as follows:
 - a. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting sub-contractor. Include on or after the cover sheet sufficient space for review stamps.
 - b. Indicate any deviations from Contract Document requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
 - c. A product data index and complete equipment list including for each product submitted for approval the manufactures name and part number, including options and selections.
 - d. Cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by prominent notation (an arrow, circle, or other means) on each sheet the exact product and options being submitted.
 - e. Submit design data, when the scope of work requires, including calculations, schematics, risers, sequences, or other data.
 - f. Submit shop or coordination drawings, when the scope of work requires, including accurate to scale device layouts, diagrams, and schedules specifically prepared to illustrate the submitted portion of work. Shop drawings shall include information to allow to the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product.
 - g. Any resubmittal shall include a complete revised equipment list and any product data that is revised.
- D. Submit complete submittal package within 30 calendar days after award of this work for approval. Equipment is not to be ordered without approval. Partial submittals are not acceptable for review. Each submittal shall include a dated transmittal.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The device manufacturer/model numbers indicated in this specification establish a standard of quality, function, and design; these devices shall not be substituted unless they are part of a factory configured system as allowed below.
- B. Factory configured systems with comparable layout and functions, are also acceptable as equivalent, as manufactured by the following:
 1. American Gas Safety
 2. Basic Lab Controls (BLC)
 3. ISIMET, LLC
 4. Lab Safety Systems – Gary Dyke (Hugh Cunningham Inc.)
 5. Lab Automation Controls Systems – Dan Ursery (E&I)
- C. Any component manufacturers/models other than those listed in this specification will require pre-approval in accordance with specification Section 26 00 90 – Electrical Submittal Procedures.

2.2 LABORATORY CLASSROOM SWITCH CONTROL PANELS

- A. Provide a custom switch panel to mount in a standard 6-gang backbox. Custom engrave a stainless-steel faceplate or cover a blank stainless-steel faceplate with a custom overlay made of Rowmark Satins item # 122206, or equivalent, white face/red core 1/16" engraving plastic laminate. Engraving shall be 1/8" high letters as indicated on plan details. Laminate plate fabrication and engraving shall be by: Action Engraving - Farmers Branch, TX, Colonial Engraving, Co., Inc. - Kingston, NH, Kyle Design - Livermore, CA, Lumen ID - Seattle, WA, or equivalent.
- B. The custom switch panel shall include 4 function rocker switches, one per control function, each with LED status indicator lamps, as required for the below listed control functions in each laboratory classroom. This controller shall manage the student laboratory workstation and the teachers' laboratory demonstration station utilities within the room.
- C. Lever Toggle Switches shall be Leviton # 1221-2R, Red Rocker, 1-pole, 20A, or equivalent.
- D. Locate the switch panel flush in the demonstration station, wall, or other fixture, as indicated on plans. The control switch functions shall be as follows:
 - 1. "EMERGENCY SHUT-OFF" 30mm N.C. red mushroom switch with key reset – Schneider Electric Harmony emergency stop switch consisting of a ZB5AS934 Head, ZB5AZ902 Anti-rotation plate, and ZB5AZ102 Single contact block with body/fixing collar, or equivalent. Mounting hole diameter 0.87 inch (22 mm). Contractor shall paint all mushroom switch keys red to identify them.
 - 2. "OFF - ENABLE (10-HOURS)" Reset key switch – Leviton # 1221-2KL, 1-pole, 20A, single action maintained, to enable and disable system and countdown timer for a 10-hour duration. All reset keys are to remain unpainted to identify them
 - 3. Student lab stations "ELECTRIC" Lever Toggle Switch – Student Lab Stations, shut-off power to the dedicated lab station outlets (receptacle power).
 - 4. Student lab stations "WATER" Lever Toggle Switch – Student Lab Stations, shut-off the domestic water (hot and cold).
 - 5. Demonstration station "DEMO UTILITIES" Lever Toggle Switch – Demonstration station, shut-off all utilities including:
 - a. Demonstration station utilities lab station dedicated outlet (receptacle power).
 - b. Demonstration station utilities lab station domestic water (hot and cold).
 - 6. "PURGE FAN (1-HOUR)" Lever Toggle Switch – Purge Fan, activate area exhaust fan for the duration of one-hour.
- E. Also acceptable are ISIMET LA screw on wall panel with remote 5000 series controller systems LAIP-5214-K-C / 5104-R series with switches, stainless-steel unit for wall flush mounting with 1/2" mounting flange, factory labeled panel with remote panic input, emergency mushroom switch, utility function rocker switches, purge fan function rocker switch, each with LED status indicator lamps, and key operated service switch as listed above and a remotely mounted plain face controller panel, or products by American Gas Safety, Basic Lab Controls, Lab Safety Systems, or Lab Automation Controls Systems providing equivalent form and functions.

2.3 PREPARATION ROOM SWITCH PANELS

- A. Provide a switch panel with a reset key switch, utility function rocker switch, and a purge fan function rocker switch in each laboratory preparation room as indicated on the project plans. Controls shall affect only the utilities within that preparation room.
- B. Provide a custom switch panel to fit a standard 4-gang backbox. Custom engrave a stainless-steel faceplate or cover a blank stainless-steel faceplate with a custom overlay made of Rowmark Satins item # 122206, or equivalent, white face/red core 1/16" engraving plastic

lamine. Engraving shall be 1/8" high letters as indicated on plan details. Lamine plate fabrication and engraving shall be by: Action Engraving - Farmers Branch, TX, Colonial Engraving, Co., Inc. - Kingston, NH, Kyle Design - Livermore, CA, Lumen ID - Seattle, WA, or equivalent.

- C. Lever Toggle Switches to be Leviton # 1221-2R, Red Rocker, 1-pole, 20A.
- D. Locate on the wall in the preparation room, below the light switch if necessary, as indicated on plans. The control switch functions shall be as follows:
 - 1. "EMERGENCY SHUT-OFF" 30mm N.C. red mushroom switch with key reset – Schneider Electric Harmony emergency stop switch consisting of a ZB5AS934 Head, ZB5AZ902 Anti-rotation plate, and ZB5AZ102 Single contact block with body/fixing collar, or equivalent. Mounting hole diameter 0.87 inch (22 mm). Contractor shall paint all mushroom switch keys red to identify them.
 - 2. "OFF - ENABLE (10-HOURS)" Reset key switch – Leviton # 1221-2KL, 1-pole, 20A, single action maintained.
 - 3. "UTILITIES" Lever Toggle Switch – Preparation Room, shut-off all utilities including outlets (lab station receptacle power), and domestic water (hot and cold).
 - 4. "PURGE FAN (1-HOUR)" Lever Toggle Switch to activate area exhaust fan for the duration of one-hour.
- E. Also acceptable are ISIMET LA independent unitized control units LA-1213-R-EX-IP series independent controller panel with switches, stainless-steel unit for wall flush mounting with 1/2" mounting flange, factory labeled panel with remote panic input, emergency mushroom switch, utility function rocker switch, purge fan function rocker switch, each with LED status indicator lamps, and key operated service switch as listed above, or products by American Gas Safety, Basic Lab Controls, Lab Safety Systems, or Lab Automation Controls Systems providing equivalent form and functions.

2.4 EMERGENCY SHUT-OFF WALL SWITCH

- A. Provide wall mount mushroom switches as indicated on project plans. When an "EMERGENCY" switch is pushed in, it shall provide emergency shut-off for all area manual utility switch panel functions at once, shut-off all other electrical outlets in the controlled area, including general purpose and computer (Additional Area Receptacles), and automatically activate the area purge fan to operate for a one hour duration.
- B. The mushroom emergency shut-off wall switch shall have the following features:
 - 1. Mushroom octagon switch shall mount on a standard flush single gang backbox.
 - 2. UL Listed
 - 3. ADA Compliant
 - 4. Button – push to activate, key to reset. Button shall be labeled "PUSH HERE"
 - 5. Shell to UV-stabilized Polycarbonate red or yellow color housing with contrasting color lettering.
 - 6. Shell Phrase: EMERGENCY POWER OFF molded in.
 - 7. Stopper Station Shield Cover to protect from accidental activation, clear polycarbonate material.
 - 8. One N.O. / one N.C., SPST gold-plated contacts rated for 3 amps @ 600 VAC.
 - 9. Safety Technologies Inc. model 19030 reset key #SS102, all stations are to be keyed alike.
 - 10. Safety Technologies Inc. model SS-2220PO or equivalent.
 - 11. Contractor shall paint all emergency shut-off wall switch yellow to identify them.
- C. Also acceptable are ISIMET IP-O-C remote wall mount switch, momentary red or yellow push button assembly with a clear flip-up protective cover and wall back box for flush mounting, or

products by American Gas Safety, Basic Lab Controls, Lab Safety Systems, or Lab Automation Controls Systems providing equivalent form and functions.

2.5 UTILITY CONTROL PANEL ENCLOSURES, TIMERS, AND RELAYS

- A. Provide as required enclosures for the relay and timer components per the drawing details and as listed below in this specification.
- B. Provide sizes as required NEMA Type 1 General purpose indoor enclosures, powder coated (gray or white color preferred), with hinged door. Size enclosures as required for each set of timers and relays. Mount enclosures in a service accessible location in and adjacent electrical room or as required.
- C. Provide as required to control -A receptacles, -L and utility output, fan change-over, and purge fan activation, see plan details:
 - 1. Relay-In-a-Box model RIBU1C or equivalent.
 - 2. Description: Enclosed relay, 10 Amp contacts, SPDT, 120 VAC or 208/277 VAC coil with LED indicator.
 - 3. Mounting Configuration: 1/2" knockout hub mount.
 - 4. 12 or 24 volt pre-engineered systems providing equivalent functions are also acceptable.
- D. Provide one System Timer (System Enable Interval Timer Relay) per Utility Control Panel Enclosure.
 - 1. Description of Function: Upon application of input voltage via the keyed switch turned to on, the output is energized (enabling the manual utility switches) and the time delay begins. At the end of the time delay, the output is de-energized. Input voltage must be removed to reset the time delay relay. Such that switching the key off and back on will restart the interval and the system will be enabled for an additional 10-hours duration.
 - 2. Mounting Configuration: 2" x 2" encapsulated, panel mounted with one screw.
 - 3. Macromatic model THR-3856U or equivalent, encapsulated time delay relay, 120 VAC coil, set for Delayed Interval function with delay interval (t1) set at the minimum 0.1 seconds, and set interval on (t2) at 600 minutes (10-hours).
 - 4. Note that equivalent functioning 12 or 24 volt pre-engineered systems are also acceptable.
- E. Provide one Fan Timer (Purge Fan Interval Timer) per Utility Control Panel Enclosure.
 - 1. Description of Function: Upon application of input voltage, the output is energized allowing for activation of the Fan Timer and Purge Fan Relay via the Fan Change-Over Relay, either through grounding with the manual purge fan switch or automatically grounding with the -A relay is de-energized by an in room mushroom emergency shut-off switch. At the end of the Fan Timer interval, the output will be de-energized. The Fan Timer time shall be reset whenever the input voltage is removed. In other words, flipping the Purge Fan switch down and back on, at any time other than when the system is in emergency shut-off mode, will restart the interval and the purge fan will run for a duration of 1-hour.
 - 2. Mounting Configuration: 2" x 2" encapsulated, panel mounted with one screw.
 - 3. Macromatic model THR-3816U or equivalent, encapsulated time delay relay, 120 VAC coil, set for Interval function with interval on set at 60 minutes (1-hour).
 - 4. Note that equivalent functioning 12 or 24 volt pre-engineered systems are also acceptable.

2.6 ELECTRICITY (RECEPTACLE POWER) SHUT-OFF CONTACTORS/ENCLOSURES

- A. Provide separate shut-off contactors/enclosures shall for each of the following functions:
 - 1. Classroom lab station dedicated receptacle group (Functionally Normally Open), circuit call outs with an “-L” suffix.
 - 2. Classroom Additional area electrical receptacle group (Functionally Normally Closed), circuit call outs with an “-A” suffix.
 - 3. Teacher’s laboratory demonstration station lab station dedicated receptacle group (Normally Open), circuit call outs with an “-L” suffix.
 - 4. Preparation room lab station dedicated receptacle group (Functionally Normally Open), circuit call outs with an “-L” suffix.
 - 5. Preparation room Additional area electrical receptacle group (Functionally Normally Closed), circuit call outs with an “-A” suffix.
- B. Power to the designated laboratory use; student lab station/demonstration station or preparation room electrical outlets only, shall feature Normally Open operation, controlled by the system panel switches, and for the system programmed durations, in the same manner as the other utilities.
- C. All other electrical outlets in the same room, including computer and general purpose outlets (Additional Area Receptacles); shall be Normally Closed operation, shut down only by the Emergency Shut-Off mushroom switch. The computer and general purpose outlets shall not be shut-off by the utility switches or any system programmed durations.
- D. Provide multi-pole contactors configured to control the electrical receptacle groups as indicated on plans.
 - 1. Enclosure shall be NEMA Type 1 General purpose indoor enclosures, powder coated (gray or white color preferred), size enclosures as required.
 - 2. Each enclosure shall house electrically held 120 VAC coil normally open or normally closed power contactors as required, with poles for the required number of circuits.
- E. Provide NEMA Type 1 enclosures with 120 VAC coil normally open or normally closed definite purpose electrically held contactors for non-motor (resistive) loads with top and/or side auxiliary contacts as applicable.
- F. Also acceptable are ISIMET E–31xx-S-L series contactor enclosures 120 VAC operation, normally open for -L circuits or ISIMET E–31xx-S-L series 120 VAC operation, normally closed for -A circuits, where “xx” is the number of contacts. Equivalent products by American Gas Safety, Basic Lab Controls, Lab Safety Systems, or Lab Automation Controls Systems providing equivalent form and functions are also acceptable.

2.7 WATER SOLENOID VALVE ENCLOSURES

- A. Provide as required NEMA Type 1 General purpose indoor enclosures of steel construction and powder coated (gray or white color preferred).
- B. Solenoid valves must be mounted with solenoid shaft vertical and upright.
- C. Valve enclosures must be mounted in a service accessible location, concealed above a drop ceiling when possible.
- D. See below for required solenoid and option features.
- E. Also acceptable are ISIMET S–3113*–†–S-F-A series; where * is the number of solenoids and † is the solenoid valves pipe size, or products by American Gas Safety, Basic Lab Controls,

Lab Safety Systems, or Lab Automation Controls Systems providing equivalent form and functions.

2.8 DOMESTIC WATER SHUT-OFF SOLENOIDS

- A. Provide solenoid assemblies for the intended use as required (hot and cold shut-off) and pipe size construction as scheduled.
- B. All solenoids are to be located within an enclosure.
- C. Provide water hammer arrestor in the flow stream at each domestic water service assembly.
- D. Provide a ball valve service shut-off up-stream from each solenoid and a wye-strainer.
- E. Provide each solenoid with a reset fuse/switch.
- F. Solenoids to feature a 120 VAC coil (12 or 24 volt pre-engineered systems are also acceptable), two-wire control, normally closed. 2-3 psi differential.
- G. Refer to the plumbing sheets in the project documents for solenoid valve pipe sizes.
- H. $\frac{3}{4}$ " Cold water solenoids to be ASCO Red Hat Buna seal general service catalog number 8210 G009 or equivalent.
- I. 1" Cold water solenoids to be ASCO Red Hat Buna seal general service catalog number 8210 G004 or equivalent.
- J. $\frac{3}{4}$ " Hot water solenoids to be ASCO Red Hat ethylene propylene seal hot water valves catalog number 8210 G009 HW or equivalent.
- K. 1" Hot water solenoids to be ASCO Red Hat ethylene propylene seal hot water valves catalog number 8210 G004 HW or equivalent.
- L. Also acceptable are ISIMET S-200 series (cold water) and S-500 series (hot water) solenoids or equivalent products by American Gas Safety, Basic Lab Controls, Lab Safety Systems, or Lab Automation Controls Systems.

PART 3 EXECUTION

3.1 EXAMINATION, COORDINATION, AND SCOPE OF WORK

- A. Do not begin installation until submittal/coordination drawings have been properly reviewed.
- B. It shall be the responsibility of the Plumbing Contractor (Refer to Division 22) to install the system devices provided, make final connections to all utility piping systems where indicated, and make other provisions for the Laboratory Utility Shut-off System as required and outlined in the Drawings and Specifications. In addition, the plumbing contractor shall provide shock arrestors upstream at each domestic water service valve assembly.
- C. It shall be the responsibility of the Mechanical Contractor to provide equipment, devices, and other provisions for the Laboratory Utility Shut-off System to control the area purge exhaust fan as outlined in the Drawings and Specifications.

- D. It shall be the responsibility of the Electrical Contractor to provide in his base proposal all equipment, devices, and other provisions for the laboratory safety system as outlined in the drawings and specifications.
- E. The electrical contractor shall install all panels, controls, and devices not requiring connection to utility piping systems.
- F. The electrical contractor shall also provide all conduit systems, standard electrical boxes, 120 VAC operating power and wiring for the laboratory safety system as outlined in the drawings and specifications.
- G. Each Utility Controller shown on the drawings and herein specified shall operate as an independent control system.
- H. The electrical contractor shall coordinate system testing of all utility piping and devices with the plumbing contractor.
- I. The Electrical Contractor shall be responsible for all system configuration, integration, testing, and start-up.

3.2 PRECONSTRUCTION MEETING

- A. Within ninety days of scheduled commencement of the electrical rough in phase of construction, this Contractor shall schedule, plan, and conduct a preconstruction meeting with the builder's job superintendent, electrical contractor, and the plumbing contractor to cover coordination, planning issues, scheduling, and scope of work with the particular subcontractors.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's recommendations and instructions.
- B. Verify that the mounting heights of all control switches comply with ADA and TAS standards.
- C. Furnish and install all devices as shown on drawings and as specified herein. Where device is to be installed by other trades, furnish, and turn over to appropriate trade for installation.
- D. Furnish, install, and make final connections to all switches, solenoids, and relays as indicated on Drawings and specified herein.
- E. Provide conduits for wiring from point of connection to each device to a service accessible point above ceiling.

3.4 TESTING, WARRANTY, SERVICE

- A. A qualified representative of the contractor shall supervise the final connections and testing of the system and it shall be subject to the final acceptance of the Architect/Engineer and Owner.
- B. The System Contractor shall make a thorough inspection of the complete installation to ensure the following:
 - 1. All components and control devices are installed to comply with manufacturer's requirements and recommendations and that all devices and installations conform to Drawings and Specification requirements.
 - 2. Each system is complete and functional.
 - 3. All wiring shall test free from all grounds, crosses, and shorts.
 - 4. Leak testing for all pipe systems.

5. Verify that all controlled piping systems have been thoroughly cleaned.
 6. Verify that all controlled devices and circuit breakers are ON.
 7. Verify that all switches perform the specified functions.
 8. A representative of the Owner shall be present for all testing. Testing shall verify design and performance requirements as specified.
- C. The contractor shall provide a warranty of the installed system against defects in material or workmanship for a period of one (1) year from the date of substantial completion. Any devices or wiring shown to be defective shall be replaced, repaired, or adjusted free of charge. All labor and materials shall be provided at no expense to the Owner. All equipment will carry a one year warranty or manufacturer's warranty whichever is greater.

3.5 DRAWINGS, MANUALS, AND TRAINING

- A. As-built drawings and operating and maintenance manuals may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- B. Upon completion of the installation, and prior to final inspection, the Contractor shall furnish as-built drawings.
- C. In addition, the contractor shall furnish complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets. Manuals shall include wiring diagrams to indicate internal wiring for each device and the interconnections between the items of equipment. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system. Provide a parts list with manufacturer and model number for commonly replaced parts. Include complete instructions for the inspection, testing, and maintenance of the system. Include copies of all device settings and programming sheets used to configure the system.
- D. Provide sets of reset keys, minimum one set per room, to the Owner's representative.
- E. This contractor shall conduct formal on-site training sessions. Provide documented general instruction as follows:
1. Provide instruction to the maintenance personnel to include the location, inspection, maintenance, testing, and operation of all system components. Provide a minimum of two (2) hours.
 2. Provide instruction to the designated users on the operation of the system and how to utilize the system to their best benefit. Provide a minimum of two (2) hours.

END OF SECTION

SECTION 26 09 21

CONTACTORS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

- A. Contactors with enclosures

1.1.2 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 00 90 - Electrical Submittal Procedures

1.2 REFERENCES

- A. UL 508
- B. NFPA 1C52-211B

1.3 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, Division 26 and Section 26 00 90 requirements.
- B. Product Data: Voltage and ampere rating, wiring diagram, enclosure type, coil voltage, and switching source(s).

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Asco
- B. Eaton Corporation (formerly Cutler-Hammer)
- C. General Electric
- D. Siemens
- E. Square D
- F. All other manufacturers shall require pre-approval in accordance with specification section 26 00 00 – Electrical.

2.2 EQUIPMENT

2.2.1 GENERAL

- A. Rated for system voltage and continuously current rated.

- B. Size as required for connected load. Locate, unless noted, in Electrical/Equipment Room near panelboard with identification label as specified in other section.
- C. Provide in an Enclosure Suitable for the Environment:
 - 1. Indoor: NEMA 1
 - 2. Outdoor: NEMA 4
- D. Provide a lightning arrestor on all outdoor contactors.

2.2.2 MECHANICALLY-HELD LIGHTING CONTACTORS

- A. Rating: Rated for all loads, tungsten ballasts and resistance heating, 30 amps contact rating minimum.
- B. Features:
 - 1. Electrically operated by a solenoid mechanism.
 - 2. Mechanically latched.
 - 3. Coil clearing contacts to de-energized coils when device is held closed.
 - 4. Required relays and controls for momentary latching and unlatching of single-pole switch contactors.
- C. Noted: "M.H. Contactor" or "M.H.C." on drawings.

2.2.3 ELECTRICALLY-HELD LIGHTING CONTACTORS

- A. Rating: Rated for all loads, tungsten ballasts and resistance heating, 30 amps contact rating minimum.
- B. Features
 - 1. Electrically held.
 - 2. Coil suitable for continuous energizing.
- C. Noted: "E.H. Contactor" or "E.H.C." on drawings.

2.2.4 CONTROL CIRCUIT

- A. Compatible with the actuating devices.
- B. Fused control circuit transformer where required.
- C. Provide required control circuit (coil) voltage, including relays (also for distance control) and coil clearing contacts. Two wire remote control relay for mechanically held contactors.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mount contactors in electrical room, mechanical room or designated area on plans.
- B. Provide contactors with number of poles noted for exterior lighting.
- C. Mount in an orderly manner between approximately 6'-0" above finish floor and secure with appropriate mounting hardware.

- D. Provide mechanically held lighting contactors with 24V coils for all exterior lights, even if not shown on the plans, grouped by the following:
 - 1. Exterior Wall Packs
 - 2. Soffit Lights
 - 3. Flag Pole Lights
 - 4. Walk way Lights
 - 5. Parking Lot Lights Designated as Security Lights
 - 6. Each Individual Parking Lot
- E. Each contactor shall have an over-ride switch located at each contactor.
- F. The contactors will be controlled by EMCS.
- G. Verify Energy Management Control requirements with EMCS installer. Run wire to EMCS control panel as required.

END OF SECTION

SECTION 26 09 41

LIGHTING CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section includes the provision of a lighting control system for the automatic dimming and deactivation of indoor lighting, except for lighting intended for 24-hour operation.
- B. This section does not include controls for theater and stage equipment.
- C. This section does not include controls for outdoor ball field lighting.

1.2 RELATED SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33.11 - Raceways and Conduits for Electrical Systems
- C. Section 26 05 53 - Identification for Electrical Systems
- D. Section 26 08 00 – Commissioning of Electrical Systems
- E. Section 26 27 26 - Wiring Devices

1.3 REFERENCES

- A. NEMA Guide Publication WD 7 Occupancy Motion Sensors Standard
- B. 2015 International Energy Conservation Code (IECC)

1.4 DEFINITIONS

- A. Motion Sensor – A sensor that detects when an occupant is in a space. This sensor can be wired or configured to be an occupancy sensor or vacancy sensor.
- B. Occupancy Sensor – A motion sensor designed or programmed to automatically turn the lighting in a space “on” when an occupant enters the space (based on major motion) and automatically turn the lighting in a space “off” after the occupant is no longer present or detected (based on minor motion) for a predetermined length of time.
- C. Vacancy Sensor – A motion sensor designed or programmed to require an occupant to manually turn the lighting in a space “on” and automatically turn the lighting in a space “off” after the occupant is no longer present or detected (based on minor motion) for a predetermined length of time.
- D. Dual Technology Sensor – A motion sensor with both infrared and ultrasonic technologies or both infrared and microphonic technologies.
- E. Photocell – A light sensitive sensor used to communicate with a room controller to dim the lighting in a daylight zone according to the ambient lighting entering a space via any method other than electric lighting.

- F. Room Controller – The local space lighting controller that interfaces with the luminaires, motion sensors, photocells, smart switches, etc. in each space to control on/off, “scenes”, dimming, and daylight harvesting. This may include the power pack, distributed controller, ballast interface modules, interface components, etc. Some or all of this function may be an integral part of the luminaires in the space.
- G. Energy Management Control System (EMCS) – May also be called Building Management System (BMS). This system is used to control mechanical systems in the building via PC software.
- H. Smart Switch – Intelligent programmable switch capable of communicating with the lighting control system in the space to trigger on/off, “scenes”, dimming, etc.
- I. Network Controller – The building-wide controller that connects Room Controllers together into a central network.
- J. Daylight Zone – Area in a space around/about a window, skylight or other fenestration measuring how far exterior natural lighting can reach into a space. Not all daylight zones can be combined. Luminaires in a daylight zone are to be controlled separately from the luminaires in the rest of the space. Some daylight zones, after they are identified in a space, will not require any change to the lighting controls already shown and may therefore be disregarded. Those will usually be deleted from the reflected ceiling plans to prevent confusion.
- K. Enhanced Building Controls (EBC) – A building interface (digital control system) intended to group all room controllers into a networked lighting control system to allow load shedding, scheduling events, remote programming, remote control via software interface, etc.
- L. Functional Testing: Start-up or testing performed by the manufacturer or certified representative to verify the operation of the complete lighting control system.
- M. Commissioning Agent: Third party hired by Owner or the design team to meet IECC commissioning requirements.

1.5 DESIGN REQUIREMENTS

- A. The system shall include all required devices for a complete and proper operating system to automatically control the lighting to meet the intent of the IECC. The system may include but not be limited to motion sensors, room controllers, enhanced building controls (if required), low voltage control wiring, photocells, smart switches, intelligent luminaires and all required boxes.
- B. Sensor design and layout: Provide the quantity of motion sensors required for complete and proper coverage without gaps within the range of coverage of controlled areas. Rooms shall have 100% coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only rooms that are to be provided with sensors. Provide additional sensors if required to properly and completely cover the respective room. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- C. Not all required components are shown on the plans.
- D. A networked distributed lighting control system is required. Relay panels are not acceptable unless noted on Lighting Control Chart.

- E. Battery operated devices and controls are not acceptable.
- F. Refer to Luminaire Schedule, Luminaire Controls Detail, Switch Function Detail and Lighting Control Chart for additional requirements and more information.

1.6 PERFORMANCE REQUIREMENTS

- A. All Spaces:
 - 1. Refer to the reflected ceiling plans and Lighting Control Chart for additional information and requirements for controlling the lighting in various areas throughout the building. For projects beyond the scope of a single system, multiple systems shall be networked together to accommodate any size requirement.
 - 2. When the fire alarm or security system activates an alarm, the lighting controls shall turn all interior and exterior building-mounted lights on to meet NFPA 101 section 7.8.1.2.2 requirements. This feature shall be provided via contact closure at the fire alarm control panel (FACP) as a trigger to the lighting control system. Provide all associated hardware and wiring from the FACP to the lighting control system necessary for a complete and working system. Refer to Lighting Control Chart for additional information.
 - 3. All portions of the controls mounted above ceiling are to be plenum rated.
 - 4. If a generator or UPS provides backup/auxiliary power to any luminaires, then power shall be provided for all lighting controls in those spaces such that all functions of the lighting control system remain operable under any power condition.
 - 5. If a generator or UPS provides emergency power to any emergency luminaires, all emergency luminaires shall turn on to maximum lumen output. If battery packs provide power for emergency lighting, all emergency luminaires shall turn on to maximum lumen rating of the battery pack.
 - 6. Wiring between sensors and control units shall be 18 AWG minimum (stranded preferred) or CAT5/5e/6. Wiring shall be plenum rated in plenum spaces and UL listed. Pre-terminated low voltage wiring from the lighting controls manufacturer is preferred.
 - 7. See the Sequences of Operation article in this specification section.
- B. Motion Sensors
 - 1. All motion sensors are to be corner (preferred) or ceiling mounted except in single toilets or small closets (< 40sqft) or unless otherwise indicated on the drawings.
 - 2. Where allowed, wall-mounted motion sensors shall be suitable for 120v or 277v lighting.
 - 3. All motion sensors shall be dual technology.
 - 4. All motion sensors to be set to a 20-minute time delay and adjusted to maximum sensitivity, unless otherwise noted on the drawings. Must be capable of being set down to 5 minutes and 1 minute for testing.
 - 5. Coverage areas for major motion and minor motion shall be determined in accordance with Section 3 of NEMA WD 7 Guide.
 - 6. Ultrasonic technology shall utilize a frequency that does not interfere with other sensors, hearing aids, smartboards, etc.
 - 7. All motion sensors on this project shall have masking or internal shielding available to control coverage pattern in the field. Stickers or other external adhesive masking will not be accepted.
- C. Timer Switches: Where indicated on the plans, a timer switch control function shall have an override not exceeding 2 hours to meet code.
- D. Smart Switches
 - 1. The smart switch shall control the luminaires in the space for all on/off, dimming and/or “scene” controls as indicated in the Lighting Control Chart on the drawings.
 - 2. For device color and cover/trim color, see specification section 26 27 26.
 - 3. The smart switch is to be used as a manual override when used with vacancy sensors.

4. Where keyed switches are indicated on the plans, the “off” feature of the smart switch is to be disabled for a schedule similar to 7a-5p. Coordinate exact schedule with Owner.
 5. All programmable switches are to be engraved or internally labeled so that the function of each button is clearly identified. All labeling or engraving must be of high quality and be provided by the lighting system manufacturer.
- E. Room Controller
1. In the event of a hardware or software or component failure, the lighting in the space is to default to the “ON” position.
 2. Provide adequate room controllers in each space for proper operation of the lighting to meet all code requirements and design intent shown on the plans.
 3. All room controllers shall utilize zero-crossing circuitry.
- F. Network Controller
1. Shall be capable of being programmed/reprogrammed via PC software. It shall be capable of receiving input via contact closure, user PC software, fire alarm control panel, etc. and issuing building-wide commands to enable/disable a scene at all luminaires inside and outside the building.
 2. Shall include astronomical time clock capable of seven different day types per week, automatic holiday “shutoff” feature for 24-hours, 12-hour minimum program backup capabilities to meet code.
 3. Shall be BTL BACNET listed for use to communicate with EMCS.
- G. See Lighting Control Chart on the drawings for controls by space and sequence of operation.
- H. To meet the enhanced digital lighting controls option of the IECC, the complete lighting control system shall be capable of meeting or exceeding all the following requirements. Each luminaire shall be capable of being addressed individually. No more than eight (8) luminaires shall be controlled together in a daylight zone. Luminaires shall be controlled through Enhanced Building Controls (EBC) that allows reconfiguration based on digital addressability, load shedding, and individual user control of overhead general illumination in open offices. Additionally, motion sensors shall be capable of being reconfigured through the Enhanced Building Controls. Lastly, all lighting controls shall be functionally tested to comply with IECC Section C408.3.

1.7 PRODUCT DATA

- A. Submit product data for all components and accessories of the lighting control system including, but not limited to:
1. Motion sensors
 2. Photocells
 3. Smart switches
 4. Time switches
 5. Room controllers
 6. Enhanced building controls (if required)
 7. Software
 8. Lighting contactors
 9. Low voltage wiring
 10. Intelligent luminaires
- B. Product data for motion sensors shall clearly indicate coverage areas for major motion and minor motion determined in accordance with the testing procedures of NEMA Guide Publication WD 7 Occupancy Motion Sensors Standard.

- C. Submit a warranty letter with warranty requirements per this specification including and describing coverage for systems that use multiple product brands to provide a complete system.
- D. Any product submitted other than from the manufacturers listed below in Part 2 will be rejected.

1.8 SHOP DRAWINGS

- A. Submit shop drawings of each reflected ceiling plan in this project showing the specific locations of all parts of the lighting control system including motion sensors, photocells, smart switches, room controllers, enhanced building controls (if required), etc. Motion sensors shown shall include sensor type, sensor mounting, and other pertinent data to allow evaluation of the proposed system.
- B. Submit a wiring diagram for all motion sensors, photocells, smart switches, room controllers, etc.
- C. Submit a sequence of operations for each unique space type describing the function of each button on each switch and the effects on the lighting in the space. This sequence of operations should be similar to the Lighting Control Chart with the added information describing how the lighting control system pieces/parts work together.
- D. Submit a list of switch types by unique space with a list of proposed button labels. This list should be similar to the Switch Function Detail with added information showing switch button layouts and actual labels for this project.

1.9 CLOSEOUT SUBMITTALS

- A. Operating and Maintenance Manuals: Provide 2 complete sets of operating, maintenance, and adjustment instructions and other information necessary for proper operation of the lighting control system. These documents shall be included as part of the project operating and maintenance manuals.
- B. As-built Drawings: Provide 2 complete sets of as-built reflected ceiling plans showing the location and wiring configuration of all motion sensors, room controllers, photocells, etc.
- C. Warranty: Provide 2 copies of warranties.
- D. Training Documentation: Provide a letter in the final documents documenting that Owner (give name of person, date, duration, and content of training) received training required in this section.
- E. System Functional Testing Documentation: Provide two (2) copies of documentation reporting the manufacturer's start-up, adjusting, and final testing of the completed installation. Include a list of controllable points to the BMS provider upon completion of lighting controls functional testing.
- F. Software Maintenance Agreement: Provide 2 copies of the software maintenance agreement.

1.10 REGULATORY REQUIREMENTS

- A. UL Label: All lighting control system products shall be UL-labeled, individually and as a system, for the specific applications utilized on this project.

1.11 MOCK-UPS

- A. Provide a product demonstration by the manufacturer of the lighting control system including a sample of each piece and part demonstrating a complete working system. If a product demonstration is not acceptable by Owner or Architect, provide, at additional cost, a mock-up of required space types with complete controls for owner / engineer / construction administration review before installation throughout the building.

1.12 PRE-INSTALLATION MEETINGS

- A. Meet with the manufacturer of the lighting controls on-site to review installation, wiring methods and exact equipment locations of all components prior to starting installation. At this meeting Contractor shall be trained by the manufacturer or vendor on the installation, setup and functionality of the system. Failure to have this meeting will result in Contractor assuming full responsibility of all costs incurred to move controls and sensors, replace equipment due to product damage, costs due to installation errors or failure to meet the full intent of the design.

1.13 STORAGE AND PROTECTION

- A. Store all product in accordance with manufacturer's storage requirements.

1.14 WARRANTY

- A. Provide a five-year parts and one-year labor warranty on the entire control system. Warranty coverage shall begin at the time of Project Substantial Completion.

1.15 SYSTEM STARTUP

- A. Provide the initial programming, aiming and start-up of the system.
- B. After system startup and prior to substantial completion of the project, require the manufacturer to test the operation of the complete system (all pieces, every space) to ensure the proper operation of the system throughout the range of building operating conditions. Provide documentation of such functional testing in the closeout submittals. Do this functional testing on all projects, regardless of other additional commissioning or testing requirements.

1.16 OWNER'S TRAINING

- A. After functional testing is complete, manufacturer shall provide a minimum of 4 hours of on-site training to Owner's personnel in the operation, adjustment, and maintenance of the system. Do this training in a location where it can be recorded by Owner. Coordinate date, time and location of training one week prior to meeting and provide documentation of such training in the closeout submittals.

1.17 THIRD PARTY COMMISSIONING

- A. In addition to functional testing by Contractor and the manufacturer, additional third party commissioning is required to meet IECC requirements. The manufacturer shall be present during the third-party commissioning process. See specification section 26 08 00 for more information.

1.18 EXTRA MATERIALS

- A. In addition to extra materials called for elsewhere in the specifications, include in the base bid:
 - 1. Provide 3 room controllers.
 - 2. Provide 6 motion sensors.

3. Provide 3 smart switches (6 or more buttons).

1.19 MAINTENANCE SERVICE

- A. Provide a three-year manufacturer's software service agreement with the system. The agreement shall cover all minor updates, bug fixes and maintenance to the software of the system to maintain all original functionality. The software service agreement shall start at the time of substantial completion.

1.20 SYSTEM SUPPORT

- A. Provide five-year complete system support starting from substantial completion. The entire lighting control system (hardware and software) shall be included in the support. The support shall include phone and email communication (as a minimum) for the duration of the support. The system support shall include all technical support, hardware and software questions, warranty help, etc.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. If they comply with these specifications, products of the following, and only the following, manufacturers will be acceptable:
 1. Acuity Controls - Chris Sears at 214-658-9030
 2. Crestron - Chris Sears at 214-658-9030
 3. Douglas Lighting Controls - Brendan Kenna at 214-247-7415
 4. Eaton Controls - Allen Pilgrim at 817-267-9300
 5. Encelium - Grant Grubb at 214-413-7034
 6. Hubbell Controls - Grant Grubb at 214-413-7034
 7. Intelligent Lighting Controls – Randy Schwimmer at 972-406-8700
 8. Leviton - Grant Grubb at 214-413-7034
 9. Lutron - Allen Pilgrim at 817-267-9300
 10. Philips Controls - Brendan Kenna at 214-247-7415
 11. WattStopper - Grant Grubb at 214-413-7034
- B. No other manufacturers will be accepted.

2.2 MANUFACTURED UNITS

- A. All parts of the lighting control system shall be warranted by the same company.
- B. All parts of the lighting control system shall be from the approved list of manufacturers above.
- C. All parts of the lighting control system shall be aesthetically compatible. i.e., from the same product line or family of products.
- D. All sensors shall be from the latest release generation. Do not mix product of different releases or generations.

PART 3 EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

- A. If the work is to be performed in an existing facility, visit the site of the proposed work and observe its conditions so that you may be fully informed as to the materials, labor, workmanship and conditions under which the work is to be done. If an existing lighting control system exists, then the new system shall work with the existing system.
- B. No allowances shall be made on account of any errors, negligence or failure to be aware of the condition of the existing site.

3.2 INSTALLATION

- A. General
 - 1. Provide all lighting controls as required and where indicated, in accordance with manufacturer's written instructions and project shop drawings, applicable requirements of the NEC, and recognized industry practices to ensure that products serve the intended function.
 - 2. Provide the room controller as required located above the ceiling above the switches near the exit door. Provide a permanent label on the ceiling t-grid to identify its location. The label material shall be as described in specification section 26 05 53. The label shall say "Lighting Controller". It is acceptable for a room controller to serve more than one space.
 - 3. Provide conduit and wiring in accordance with specification sections 26 05 33.11 and 26 05 19.
- B. Shop Drawing Preparation: At least five working days prior to bid time, provide a set of floor plan drawings and a copy of these specifications to the manufacturer for the purpose of system layout with quantities and creating shop drawings for the owner. Coordinate with the manufacturer to determine the required medium (hard copy or electronic) and the format required by the manufacturer.
- C. Sensor Design and Layout by Manufacturer:
 - 1. Refer to Design Requirements article regarding sensor design and layout.
 - 2. Exact locations of control unit hardware boxes shall be based on observing good installation practice and shall be coordinated with other elements of the reflected ceiling plan. Control unit hardware shall be fully concealed.
 - 3. Select the appropriate type of sensor for complete coverage of each space.
- D. Lighting Control Cable Routing and Installation:
 - 1. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical code requirements.
 - 2. Cable pathways, conduit, and cable support systems shall be complete with bushings, de-burred, cleaned, and secure prior to installation of cable.
 - 3. All wiring shall test free from opens, grounds, or shorts. All lighting control cable shall be supported from the building structure and bundled. Do not attach any supports to joist bridging or other lightweight members.
 - 4. Support system shall provide a protective pathway to eliminate stress that could damage the cabling. The lighting control cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends that could compromise the integrity of the cabling.
 - 5. Lighting control cable must not be fastened to electrical conduits, mechanical ductwork/piping, sprinkler pipes, or routed to obstruct access to hatches, doors, utility access panels, or service work areas. Do not route cables through fire doors, ventilation shafts, grates, or parallel with line voltage electrical conductors. Lighting control cables shall not be run loose on ceiling grid or ceiling tiles.

6. Support shall be provided by mounting appropriate fasteners that may be loaded with multiple cables. Provided that the weight load is carried by the support rod or wire, the support assembly may attach to the ceiling grid for lateral stabilization. The required support wires for the ceiling grid or luminaires shall not be utilized. Any fastener attached to the ceiling grid shall not interfere with inserting or removing ceiling tiles. The cable pathway of supports must be positioned at least 12 inches above the ceiling grid.
 7. Provide bushings to protect the cable from damage for conduit ends, box openings, and passage through metal studs.
 8. Lighting control cables shall be run in bundles above accessible ceilings and supported from building structure. Cabling shall be loosely bundled with cable Velcro hook ties randomly spaced at 30 to 48 inches on center, cable ties shall not be tight enough to deform cabling and shall not be used to support the cabling.
 9. Each cable run shall include a three-foot service loop with Velcro hook ties located in the ceiling above each device. This is to allow for future re-termination or repair.
 10. Lighting control cable will not be installed in the same conduit, raceway, tray, duct, or track with line voltage electrical cable without a metallic barrier meeting NEC requirements.
 11. Maximum cable pulling tension should not exceed 25 pound-force (110 N) or the manufactures recommendation, whichever is less.
 12. Any pulling compounds utilized must be approved by the cable manufacturer and shall not degrade the strength or electrical characteristics of the cable.
 13. No terminations or splices shall be installed in or above ceilings, other than in designated end point housings.
 14. Cable bends shall not be tighter that the manufacturers' suggested bend radius.
 15. Mount all equipment firmly in place. Route cable in a professional, neat and orderly installation.
- E. Lighting Control Cable Support
1. Conduit, duct, or track shall be used for lighting control cable in exposed areas.
 2. Cable fill shall not exceed the manufacturers' instructions for each type of support.
 3. All conduit, ducts, track, and raceways shall be supported from the structure at industry standard intervals for the size specified, utilizing proper anchoring devices.
 4. All vertical supports shall be attached to the building support structure or concrete ceiling with anchors load rated for 100-lbs. minimum. Down rods shall be a minimum of 1/4" diameter. Steel uni-strut cross supports shall be 2" minimum.
- F. Bushings
1. Provide a plastic snap in bushing at each box opening, passage through a metal stud, and at the end of all open conduit stubs or sleeves prior to lighting control cable installation to protect the cabling from damage:
 - a. Box openings - Thomas & Betts Knockout Bushing Series 3210, or equivalent.
 - b. Metal stud passage - Thomas & Betts Twist It Bushing Catalog Number SB1216-SC, or equivalent.
 - c. Conduit ends - Thomas & Betts Anti-Short Bushing Series 390 or Tite-Bite Combination Couplings Series 442, or equivalent.
- G. J-Hooks
1. Attachments for cabling support shall be spaced at approximately 48 to 60 inches on center. Cable bundles shall not be allowed to sag down more than 12-inches mid-span between attachments.
 2. All attachments shall be approved for category rated twisted pair cabling. Attachments shall be Caddy part numbers as follow, or equivalent, sized as follows:
 - a. CAT16HP, 1" diameter Capacity 15 Category rated cables.
 - b. CAT21HP, 1.31" diameter Capacity 40 Category rated cables.
 - c. CAT32HP, 2" diameter Capacity 60 Category rated cables.
 - d. Split bundles greater than 2" dia. or provide cable tray.

3. Do not mix different signal strength cables on the same J-Hook (i.e. fire alarm with data and telephone cable). Multiple J-Hooks can be placed on the same attachment point, up to the rated weight load of the attachment device.
- H. Cable Tie Wraps
1. Provide and install Panduit TAK-TY cable ties or equivalent.
 2. Velcro hook cable ties shall be furnished and installed to attach wire bundles to supports and for appropriate wire management as required.
 3. Hard plastic or metal tie wraps will not be allowed on any data grade cable (Category rated twisted pair cable).

3.3 SEQUENCES OF OPERATION

- A. Lighting Controls
1. The smart switch shall be required to be pressed to turn the lights on in all spaces where a vacancy sensor is required. Otherwise, an occupancy sensor may automatically turn the luminaires on. Two minutes prior to turning the lights off, the lighting controls shall dim the luminaires in the space to 50% of their previous output as a notification to the occupants that the controls will soon turn the lighting off. A momentary “blink” is allowed if luminaires are not dimmable. If the motion sensor is not triggered in two minutes, the lighting in the space is to turn off. If the motion sensor is triggered, the lighting controls shall dim the lighting back up to the previous lighting level and timeout is restarted. In spaces with timer switches, the system shall accept an override signal at any time either before or after the lighting is turned off. The occupant shall not be required to wait for the lights to go out before issuing the override.
 2. Where shown on the plans, a photocell is to be used to measure the light level and signal to the room controller to dim the luminaires continuously (from 100% to 15% or lower, including off) in the daylight zone to maintain a consistent (within +10% and -0%) lighting level in the space.
- B. Enhanced Building Controls – Load Shedding: The system shall allow for the definition of at least four user defined groups of actions. These actions shall include, but not be limited to, switching and/or dimming of user-defined selected lighting loads. The system shall be capable of carrying out one or more of these groups of actions under each of the following conditions.
1. The current 15-minute metered electrical demand is less than the billing demand as calculated by the local electrical utility.
 2. The current 15-minute metered electrical demand is more than the billing demand as calculated by the local electrical utility, but less than the 12-month peak demand.
 3. The current 15-minute metered electrical demand is more than the 12-month peak demand.
 4. In the case where the customer has a negotiated agreement with the local utility where the customer agrees to shed certain loads in return for discounted electrical rates, the system shall be capable of receiving a signal from the local electric utility and carrying out the agreed actions.

3.4 MANUFACTURER’S FIELD SERVICES

- A. Coordinate with the sales representative to coordinate the below requirements with the manufacturer.
1. The manufacturer shall provide instruction at the start of the job to Contractor regarding the proper installation of the system.
 2. As part of the system startup process, the manufacturer shall provide all initial field programming of the system.
 3. Using certified factory representatives, the manufacturer shall inspect the finished installation against the shop drawings and installation instructions.
 4. Using certified factory representatives, the manufacturer shall do functional testing of the

finished installation. Submit documentation of the functional testing in accordance with Part 1 of this specification.

3.5 ADJUSTING

- A. Motion sensors may be affected by various conditions in the room. It may be necessary for Contractor to make adjustments, change the location or type of sensor to obtain proper operation in a specific room. Contractor/equipment manufacturer shall have final responsibility for proper operation and coverage of the system in each room and should therefore make labor allowance for such changes and adjustments. Contractor is also responsible for acquiring approval from Engineer for any changes or deviations from project specifications.
- B. Work with the manufacturer to correct all findings from manufacturer functional testing.
- C. Work with the manufacturer to correct all findings made by the third-party commissioning agent or registered design professional, whichever entity performs the commissioning service. This contractor is responsible for the entire lighting control system and luminaires to pass the commissioning inspection and reporting.

3.6 OWNER'S TRAINING AND DEMONSTRATION

- A. Upon completion of testing and adjustment, demonstrate operation of the system to representatives of Owner.
- B. Instruct Owner's personnel in proper maintenance, adjustment, and operation of the motion sensor lighting controls.
- C. Discuss with Owner the time clock feature programming requirements (on/off times and school schedule) and teach them to program the clock feature to match the required schedule.
- D. Upon completion of testing and adjustment (commissioning), Contractor and a direct employee of the equipment manufacturer (who is already familiar with the details of the project) shall demonstrate operation, proper maintenance, troubleshooting and adjustment of the lighting control system and all sensors throughout the building. Owner shall receive a minimum of 4 hours and a maximum of 8 hours in an on-site training session. The length of the training session shall be at the discretion of Owner. The training shall cover the following areas in detail:
 - 1. Scope of system: Review the as-built documentation with Owner to detail extent of system. Identify locations of all wall stations, wiring, and panels that fall within the scope of the lighting control system. Define clear lines of scope between lighting control system and EMS functions if applicable.
 - 2. Operation of system: Cover normal operation of switches, push-buttons, LCD interfaces and software (if provided). Provide documentation to Owner showing the operational zoning of controlled circuits and all time-clock events programmed into the Lighting Control System. Show Owner how to change and add/delete events.
 - 3. Maintenance and Troubleshooting of system: Detail any required or optional preventive maintenance actions required of Owner. Go over step-by-step procedures to troubleshoot all possible failure modes of each component type of the lighting control system. Cover procedure to get lights turned on in any space containing a lighting control system in the event the control system fails. Identify any specialized equipment necessary to support all the above actions.
 - 4. Service and Support of system: Identify nearest direct support contact for the manufacturer and provide both telephone and email contact details.

END OF SECTION

SECTION 26 21 00

LOW VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical service including underground primary requirements, transformer and secondary enclosure requirements, overhead and underground service entrance requirements, metering, and final connections.

1.2 RELATED SECTIONS

- A. Section 26 05 33.11 – Raceways and Conduits for Electrical Systems
- B. Section 26 24 16 – Panelboards for Distribution Switchgear

PART 2 PRODUCTS

- A. Not used.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate with the power utility company to obtain information regarding the available short circuit current at the service point. Provide this information to the electrical gear manufacturer for use in the overcurrent protective device coordination study required by section 26 24 16.
- B. Coordinate all requirements with the power utility company and include in the base bid, including but not limited to the following.
 - 1. Whether the service will be overhead or underground.
 - 2. The extent of any underground primary.
 - 3. The need for a secondary enclosure.
 - 4. Any charges from the power utility company for providing service.
 - 5. The need for a transocket for utility metering.

3.2 INSTALLATION

- A. All underground primary and secondary conduits: Provide schedule 40 PVC with PVC coated rigid metal long sweep elbows in accordance with section 26 05 33.11. Minimum cover shall be 24 inches from finished grade to top of highest conduit or power utility company requirements, whichever is greater. No trench shall exceed 58 inches in depth. Encase conduits in concrete extending 3 inches in all directions beyond the conduits perimeter. Install a pull wire and cap all conduits at both ends until the conductors are installed. Provide red or yellow plastic identification tape no more than 1'-0" below grade with the following wording: "Caution - Buried Conduit" or reasonable facsimile over the entire length of the pipe ditch.
- B. Underground primary: Provide two 4" conduits from the power utility company service point to pad-mounted transformers. Primary conductors will be provided by the power utility company. Coordinate exact location of service point with the power utility company.

- C. Pad-mounted transformer: Construct the transformer pad in accordance with the power utility company specifications. Coordinate with the power utility company before installation of concrete for exact size, location and all requirements. The transformer will be provided by the power utility company.
- D. Secondary enclosure: Coordinate with the power utility company and provide a secondary enclosure where required to transition from the transformer output to the service entrance feeder. Construct the pad for the secondary enclosure. Provide all conduit, wire, and terminations between the transformer and the secondary enclosure.
- E. Underground service entrance: Provide all trenching, conduit, conductors and electrical equipment from the secondary terminals of the transformer/secondary enclosure to the main service disconnects.
- F. Overhead service entrance: Provide all conduit, conductors, supports, weatherheads, and sleeving from the electric service point to the main service disconnects.
- G. Metering: Provide conduits, conductors, cabinets, racks, transocket, and supports as required by the power utility company for service metering. All utility metering equipment will be provided by the power utility company.
- H. Final connection: Arrange for and provide final connection by the power utility company.

END OF SECTION

SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Dry-type transformers rated 600 volt and below for general power, computer power, and lighting applications.

1.2 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 00 30 - Warranty Period
- C. Section 26 00 90 - Electrical Submittal Procedures
- D. Section 26 05 19 - Low-voltage Electrical Power Conductors and Cables
- E. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- F. Section 26 05 33.11 - Raceways and Conduits for Electrical Systems
- G. Section 26 05 33.13 - Boxes and Fittings for Electrical Systems
- H. Section 26 21 00 - Low Voltage Electric Service Entrance
- I. Section 26 28 16 - Enclosed Safety Switches And Circuit Breakers

1.3 REFERENCES

- A. UL 5085-1 Low Voltage Transformers - Part 1: General Requirements
- B. UL 5085-2 Low Voltage Transformers - Part 2: General Purpose Transformers
- C. ANSI - C33.4/C57.96
- D. NEMA-ST-20 Dry Type Transformers for General Applications
- E. IEEE 45
- F. CODE OF FEDERAL REGULATIONS, Title 10 Energy, Part 431 Energy Efficiency Program for certain commercial and industrial equipment (10 CFR Part 431)
- G. UL 1561 – Standard for Dry-Type General Purpose and Power Transformers

1.4 SYSTEM DESCRIPTION

- A. Equipment items specified by manufacturer's name, brand name or catalog number are the specific items upon which the electrical system design is based.
- B. Proposed substitute equipment shall be evaluated for design compatibility as well as for electrical and physical equality.

- C. Provide transformers of capacity required per NEC required overload protection on primary and secondary sides. Primary and secondary conductors shall be sized in accordance with the NEC.

1.5 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.
- B. Product Data: Submit product data for the following:
 - 1. Submit transformer cut sheets, shop drawings, and other pertinent data during submittal phase with other switchgear.
 - 2. Submit test data, after installation, with records for Owner manuals.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The following are approved manufacturers.
 - 1. Eaton Corporation (formerly Cutler-Hammer)
 - 2. General Electric
 - 3. Jefferson
 - 4. Siemens
 - 5. Square D
 - 6. Hammond Power Solutions
- B. All other manufacturers shall require pre-approval in accordance with specification section 26 00 00.

2.2 MANUFACTURED UNITS

- A. Ventilated transformers shall be UL 1561 listed.
- B. Insulation rating: Class 155 or higher.
- C. Temperature rise: Maximum temperature rise to be 150°C over 40° C ambient. Reduced temperature rise to be 80°C or 115°C only where noted on drawings.
- D. Load Rating: Capable of operating at 100% of nameplate rating continuously on 150°C rise, 115% on 115°C rise and 130% on 80°C rise while in an ambient temperature not exceeding 40°C. Design transformers for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy as defined in IEEE 65.
- E. Sound Rating: Audible sound levels shall be in accordance with NEMA ST-20.
- F. Energy Efficiency: All ventilated transformers rated 15 kVA and above covered by this specification section shall meet the minimum energy efficiency levels set forth in 10 CFR Part 431. Sealed and non-ventilated transformers are exempt from 10 CFR Part 431. Dry type transformers below 15 kVA are exempt from 10 CFR Part 431. Submittals shall clearly indicate compliance with 10 CFR Part 431.
- G. Coils: Continuous wound copper construction impregnated with non-hygroscopic varnish.

- H. Tap arrangement: Use in the high voltage winding unless noted otherwise on the drawings. Provide taps as follows.
 - 1. 3 KVA Through 25 KVA: 4 at 2.5% each, 2 above and 2 below nominal voltage
 - 2. 30 KVA Through 112.5 KVA: 6 at 2.5% each, 2 above and 4 below nominal voltage
 - 3. 150 KVA Through 500 KVA: 6 at 2.5% each, 2 above and 4 below nominal voltage
- I. Cores: Constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Bolt completed core and coil to the base of the enclosure and isolate by means of vibration-absorbing mounts. Metal-to-metal contact between the core and coil and the enclosure is not permitted. Visibly ground the core of the transformer to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
- J. Transformer Enclosures: Fabricate all transformer enclosures of heavy gauge, sheet steel construction. Ventilate all enclosures. Maximum temperature of the top of the enclosure: 50°C rise above a 40°C ambient. Provide a UL recognized coating for outdoor use.
- K. Color: ANSI 61 or 49 gray. Apply uniform coating to all edges and surfaces.
- L. Non-Linear transformers: K-13 or K20 with 200% neutral bar.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide K-13 transformers when serving isolated ground electrical panels.
- B. Provide K-20 transformers when serving electrical panels in major network operations centers (NOC).
- C. Mount transformers on additional vibration isolators and/or on rubber and spring isolators at floor or other mounting points to meet sound ratings. Install as per manufacturer's recommendations and/or Engineer's directions. Isolators are in addition to isolators shipped with transformers from the manufacturers.
- D. Install the transformer so that vibrations are not transmitted to the structural parts of the building. Mounting should be on a solid wall, floor, or other wall, floor, or other structure with solid mass. Mounts must be isolated and properly loaded avoiding direct contact with other metal structures. Isolate the transformer by using flexible couplings and conductors to help prevent vibrations being transmitted to other equipment. Make sure shipping braces and hold-down bolts are loosened as specified by the manufacturer's installation manual. Ventilated transformers should "float" on vibration dampening pads located between the enclosure and the core and coil assemble.
- E. Exterior weatherproof transformers: Mount on 6" thick minimum steel reinforced concrete slab. Extend slab 1'-0" beyond transformer on each side. Provide weather shields from the manufacturer.
- F. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to ensure that products fulfill requirements.
- G. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

- H. Set transformer plumb and level. Use flexible conduit, 6 ft. maximum length, for connections to transformer. Make conduit connections to side panel of enclosure.
- I. Check for damage and tight connections prior to energizing transformer. Measure primary and secondary voltages and make appropriate tap adjustments.

3.2 SITE TESTS, INSPECTION

- A. Apply standard potential, loss ratio, polarity and continuity tests to each transformer.
- B. Provide the test data results for each transformer. Provide certification of test data accumulated on similar units to show the expected values of sound levels, temperature rise, full-load losses, regulation and impedance.

END OF SECTION

SECTION 26 24 16

PANELBOARDS FOR DISTRIBUTION SWITCHGEAR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. Switchboards
- B. Branch circuit panelboards
- C. Switchgear

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- D. Section 26 05 33.11 - Raceways and Conduits for Electrical Systems
- E. Section 26 22 13 - Low Voltage Distribution Transformers
- F. Section 26 28 13 - Fuses
- G. Section 26 43 00 - Surge Protective Devices

1.4 REFERENCES

- A. UL 50 - Cabinets and Boxes.
- B. UL 67 - Electric Panelboards.
- C. NEMA AB1 - Molded Case Circuit Breakers.
- D. NEMA AB2 - Procedures for Verifying the Performance of Molded Case Circuit Breakers.
- E. NEMA PB1 - Panelboards.
- F. NEC – NFPA 70 National Electrical Code 2017

1.5 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

- A. For any project where service entrance equipment is added or changed, provide a short circuit/coordination study for the entire system.

- B. For any project where electrical panels are added or changed but the service entrance equipment is not changed, provide a short circuit/coordination study for the service entrance equipment and the affected panels.
- C. For any project involving mechanical equipment changes including chillers, cooling towers, air handlers, condensers, pumps, or rooftop units, provide a short circuit/coordination study for the affected portion of the system including affected panels and branch circuit overcurrent protective devices.
- D. Submit the short circuit/coordination to the city. The level of detail and format shall conform to city requirements.
- E. Coordinate the short circuit current ratings of mechanical equipment with the available short circuit current. The short circuit current ratings of all electrical and mechanical equipment shall exceed the available short circuit current.
- F. Adjust settings of adjustable circuit breakers to achieve selective coordination of the system. Notify the engineer if selective coordination cannot be achieved.

1.6 DESCRIPTION OF WORK

- A. All panelboards with 400 amp main circuit breakers, 400 amp main lugs or 400 amp fused and larger shall be factory assembled.
- B. The Contractor shall furnish and install approved panelboards of the types indicated and specified herein at locations as shown on the drawings.
- C. Interiors shall be completely factory assembled.
- D. Panelboard schedules on the drawings, shall govern where this specification conflicts with panelboard schedules.

1.7 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.
- B. Provide shop drawings for each electrical equipment room showing the placement of all panelboards, transformers, and other equipment such as mechanical equipment, drawn to scale and dimensioned. Such shop drawings will be reviewed for compliance with the intent of the contract drawings and the spaces available for the electrical apparatus.
- C. Clearly indicate on the submittals whether equipment is fully rated or series rated.
- D. Arrangement: Arrange panelboard submittals in the order the panelboard schedules appear on the panelboard sheets of the drawings as read from top to bottom, then left to right.

PART 2 PRODUCTS

2.1 ENCLOSURE

- A. Minimum 16 gauge cold-rolled sheet steel. Gutter wiring space shall be a minimum of 4 inches on each side/industry standard. Provide standard conduit knockouts in ends and sides of cabinet. Provide flush type combination catch and key door locks on all panelboards and load centers. Key all locks alike, provide two keys with each panelboard.

- B. Flush mounted panelboards trims shall fasten to permit both horizontal and vertical adjustment.
- C. Surface mounted panelboards trims shall fasten to insure no overhang.
- D. Bus Material shall be:
 - 1. Phase Bus: 98% IACS conductivity copper with rounded edges, tin electro-plated.
 - 2. Ground Bus: 25% phase rated, additional isolated bus in computer and communication panels.
 - 3. Neutral Bus:
 - a. 200% of phase rated copper, tin electro-plated - computer panels
 - b. 100% of phase rated copper, tin electro-plated - lighting and power panels
 - 4. Current density to be the industry standard.
- E. Install in allotted spaces so that devices can be added without additional machining, drilling or tapping.
- F. Brace to withstand symmetrical short circuit current as indicated on drawings.

2.2 CIRCUIT BREAKERS

- A. Quick-make, quick-break. Manual and automatic operation. Trip free and trip indicating.
- B. All switchgear bolt-on only. Number of poles and ampere ratings indicated for the specified service.
- C. Interrupting Ratings: As indicated on panel schedules. Panels may be noted on the drawings as fully rated due to excessive motor loads. Otherwise, panels can be fully rated or series rated for construction of new buildings. For addition and renovation work, panels with main breakers can be fully rated or series rated unless noted on the drawings as fully rated. Main lug only panels for addition and renovation work shall be fully rated.
- D. Bimetallic overload elements. Magnetic trip. Common trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.
- E. Connect to the main bus by means of a solid connection. Use breakers which are capable of being operated in any position within the panel.
- F. Independently mount so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.
- G. Provide ground fault breakers (GFCI) where indicated on the schedules and/or as required by N.E.C.
- H. Provide HACR listed circuit breakers on all HVAC equipment 60 amps or less.

2.3 CIRCUIT IDENTIFICATION

- A. Frame-mounted directory with a heat-resistant transparent face for identifying circuits. Use equipment names as reflected by Engineer. Use numbers selected by the Owner, which may differ from those shown on plans.
- B. Indicate with light, erasable pencil marking, all spares and spaces.

- C. Provide on all panelboards, revise existing panelboards per Division 26 with new information.
- D. Mount inside the panelboard door.

2.4 SWITCHBOARDS (1,000 AMPS OR MORE)

- A. Factory-assembled, dead front, metal enclosed.
- B. Switchboards rated 2,000 amps or greater shall have a minimum depth of 30".
- C. Features:
 - 1. Phase Bus: Tin plated copper of sufficient cross-sectional area to continuously conduct rated full load current with temperature rise limits in accordance with NEMA Standards, and industry standards.
 - 2. Ground Bus: Full length, sized at 25% of phase bus and bonded to each section.
 - 3. Neutral Bus: Full length, sized at 100% of phase bus.
 - 4. Fault Withstandability: Suitable for operation at the available fault current.
- D. Short Circuit Current Rating:
 - 1. Switchboard: More than 100,000 RMS symmetrical amperes.
- E. Overcurrent protection devices: Provide circuit breakers unless the drawings indicate that fused switches are required.
- F. Switch Handles: Clearly indicate on and off positions and size of breaker or fused switch.
- G. Fused Switches: Provide with Class R fuses.
- H. Circuit Breakers: Capable of field-installable shunt trip, ground fault shunt-trip or under voltage trip.
- I. Construction:
 - 1. Provide a single-withstanding short circuit current rating for each switchboard as shown on the plans.
 - 2. Provide the required number of sections of the required size to fit in the space provided.
 - 3. Connect sections with bussing. Cabled connections are not allowed.
 - 4. Use front accessible overcurrent protection devices.
 - 5. Label to indicate the maximum available fault current rating. This rating consists of the structure, bussing, switchboard main disconnects and switchboard branch circuit devices.
 - 6. Provide instrumentation as specified in Section 26 09 13 and in conjunction with Division 23-Energy Management Control System requirements.

2.5 SURGE PROTECTION

- A. Provide a surge protective device at the main switchgear in accordance with section 26 43 00.

2.6 IDENTIFICATION OF SWITCHGEAR

- A. Information shall include the following:
 - 1. Panel type
 - 2. Style
 - 3. Amperage
 - 4. Neutral amperage
 - 5. Panel voltage
 - 6. Phase
 - 7. Number of wires

- B. Provide information on each piece of equipment, on factory or contractor made nameplate.
- C. Series Rated Panels: In accordance with NEC Article 240.86(B), provide a label affixed by the manufacturer indicating the tested and approved series rating combinations. Provide an additional label affixed behind the panel door to be field marked in accordance with NEC Article 110.22(C).

2.7 MANUFACTURERS

- A. General Electric
- B. Square D
- C. Siemens
- D. Eaton Corporation (formerly Cutler-Hammer)

PART 3 EXECUTION

3.1 INSTALLATION

- A. When isolated ground devices are shown being powered from a panel, provide a complete isolated ground system including isolated ground panel with 200% neutral, SPD and separate isolated ground bus.
- B. Install in the locations as shown and as recommended in NEMA PB1.1. Mount the panelboards such that the center of the switch or circuit breaker in the highest position will not be more than 6-1/2 feet above the floor or working platform. Space all panelboards and switchboards to meet the requirements of Article 110 and 340 of the N.E.C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured.
- C. Provide required SPD breaker for each panel/switchboard as required by the manufacturer.
- D. Provide a sign at each switchboard 1600 amp and greater, which reads "Danger High Voltage" in red/white/black.
- E. Install panelboards and enclosures, including electrical connections, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the NECA "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.
- F. Coordinate installation of panelboards and enclosures with cable and raceways installation work.
- G. Connect A, B and C phases respectively to bus number 1, 2 and 3 from left to right or top to bottom. Balance panels by checking each phase of all panels under full load and arrange so that all phases carry the same load as near as possible.
- H. Furnish and install an engraved laminated nameplate for each circuit breaker or fused switch in distribution panelboards. Refer to electrical equipment identification section of the specifications. Place free standing or floor mounted equipment on housekeeping pads.

- I. Series rated panels: Field mark the factory furnished label in accordance with NEC Article 110.22(C).

3.2 INSTALLATION OF CONDUCTORS

- A. More than one conductor shall not be installed in any termination in a panelboard unless the termination is marked as suitable for more than one conductor.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

- A. AC Switches
- B. Receptacles
- C. Connectors
- D. Finish plates
- E. Relays

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- D. Section 26 05 33.13 - Boxes and Fittings for Electrical Systems

1.4 REFERENCES

- A. ANSI/UL 20 - General - Use Snap Switches
- B. ANSI/UL 498 - Electrical Attachment Plugs and Receptacles
- C. UL 943 – 2006 – Ground Fault Circuit Interrupters
- D. NEMA WD 1 - General - Purpose Wiring Devices
- E. NEC - National Electrical Code
- F. Applicable Federal Specifications - WC - 596-F, WS-896E
- G. Mounting heights per Americans with Disabilities Act

1.5 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.

- B. Product Data: Clearly mark product data for each product specified and/or proposed for use. Product data shall include, but not limited to the following:
 - 1. receptacle devices
 - 2. switch devices
 - 3. isolated ground receptacle devices
 - 4. weatherproof receptacles
 - 5. device plates
 - 6. enclosures
 - 7. keys

1.6 DESCRIPTION OF WORK

- A. Provide factory fabricated wiring devices of the type and electrical rating for the service indicated, provide proper selection to fulfill the wiring requirements. Wiring devices, including receptacles and switches shall be colored to match wall plates. Special purpose outlets shall be of appropriate color.
- B. Provide a compatible receptacle for the cap or plug and cord of all other equipment installed in this project.
- C. Relays, if any, shall be multipole, mechanically held, 30 amperes 120V operating coil, 600V contacts, auxiliary contacts as required for two wire operation, coil clearing contacts; Zenith ESS Series or equal.
- D. Provide switch, receptacle, outlet, conduit, and special purpose wall plates for wiring devices, with ganging and cutouts as indicated, provided with metal screws for securing plates to devices, screw heads colored to match finish of plate.
- E. Provide oversize plates where required to completely cover wall opening. Where oversize plates are used, all plates in room shall be oversize style.
- F. Use plates and Raco narrow gang boxes in storefront mullions and where narrow boxes are required.
- G. Mount all switches, thermostats, etc. at the same height when located horizontally within 6 feet on same wall. See mechanical drawings for thermostat locations.

PART 2 PRODUCTS

2.1 AC SWITCHES

- A. Quiet-type, commercial, specification grade, back and side-wired with grounding terminals. Furnish AC switches which comply with NEMA WD-1 Standards, UL20 and Federal Specification WC896. Special purpose switches shall be of appropriate color. Switches shall be rated for 120-277 volt AC, number of poles as required.
- B. Provide 120/277 volt NEMA 5-20 self-grounding specification grade devices only.
- C. Provide 20 ampere ratings for all loads. Rated amperage capacity shall be 100% for all lighting loads, and 80% for all motor loads.
- D. Single Pole:
 - 1. Leviton 1221-S
 - 2. Hubbell CS1221
 - 3. P&S CSB20AC1

- E. Double Pole:
 - 1. Leviton 1222-S
 - 2. Hubbell CS1222
 - 3. P&S CSB20AC2
- F. Three Way:
 - 1. Leviton 1223-S
 - 2. Hubbell CS1223
 - 3. P&S CSB20AC3
- G. Four Way:
 - 1. Leviton 1224-S
 - 2. Hubbell CS1224
 - 3. P&S CSB20AC4
- H. Keyed switches:
 - 1. Two-prong keys only. Single-prong keys will not be acceptable.
 - 2. Provide 25 extra keys
 - 3. Lock Single Pole: Leviton 1221-L (P&S 20AC1L)(Leviton 1221-2KL with WS-35 key code)
 - 4. Lock Double Pole: Leviton 1222-L (P&S 20AC2L)(Leviton 1222-2KL with WS-35 key code)
 - 5. Lock Three Way: Leviton 1223-L (P&S 20AC3L)(Leviton 1223-2KL with WS-35 key code)
 - 6. Lock Four Way: Leviton 1224-L (P&S 20AC4L)(Leviton 1224-2KL with WS-35 key code)
- I. Special Purpose Switches:
 - 1. Quiet-type, industrial specification grade, 120-600 volt AC, number of poles as required.
 - 2. Security Keyed Switch: Leviton 1221-KL; P&S PS20AC1L
 - 3. 20A. 2P Motor: 20AC2-HP (6806U-DAC); P&S PS20AC2HP
 - 4. 30A. 2P Motor: 30AC2-HP (6808U-DAC); P&S PS30AC2HP
 - 5. 30A. 3P Motor: 7803 (7810-UO); P&S 7803MD
- J. Wall timer Switches:
 - 1. Watt Stopper TS-400 with optional flash warning
 - 2. Equals by P&S RT24 series.
 - 3. Paragon will not be accepted.

2.2 RECEPTACLES

- A. Furnish receptacles which comply to NEMA WD-1 Standards, UL 498 and Federal Specification WC596F.
- B. 125 volt Nema 5-20R duplex, side wired, self-grounding with ground lug, specification grade hard use
- C. 20A. Duplex: Leviton 5362-S; P&S 5362
- D. GFCI Receptacles: 20-amp, duplex. Comply with NEMA WD 1, NEMA WD 6, UL 498, Federal Specification W-C-596, and UL943, Class A. Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:
 - 1. Pass & Seymour; 2097, 2097 (NAFTA Compliant), PT2097 (use with PTR6STRNA prewired pigtail connector), PT2097NA (NAFTA Compliant - use with PTR6STRNA prewired pigtail connector).
 - 2. Equivalent by Leviton
 - 3. Equivalent by Hubbell

- E. Isolated Ground:
 - 1. 5-20R, Leviton 53k2-IGI with Orange triangle. See Device Color article below.
 - 2. Provide at all computer/communications locations.
 - 3. Four wire with self-ground mounting strap.
- F. Clock Outlet: Leviton 5361-CH, P&S S3733SS
- G. Weatherproof Outlets:
 - 1. Provide GFCI receptacle as specified above.
 - 2. Receptacle covers protected from rain shall be zinc die-cast weather-resistant cover with self-closing lid, Leviton 4992, P&S WIUCAST1, or equivalent.
 - 3. Receptacle covers not protected from rain shall be "While-In-Use" cover, Leviton 5977DGY, P&S WIUC10DGL, or equivalent.
 - 4. Do not use feed through feature for any GFCI receptacle.
 - 5. Install separate GFCI device at each location.

2.3 VOICE/DATA OUTLETS

- A. Device and plates provided.

2.4 DEVICE PLATES

- A. In finished spaces use smooth nylon device plates and covers.
- B. At exposed boxes in dry interior spaces use heavy cadmium-plated sheet steel. Plate edges must be flush with edges of boxes.
- C. Device plate manufacturer and device manufacturer shall be the same so colors will match. Stainless steel plates will not match the device.

2.5 DEVICE COLOR

- A. Device color to be white, except as otherwise indicated or required by code.

2.6 MANUFACTURERS

- A. Products to be equivalent to the manufacturer, Pass & Seymour (P&S), and model numbers listed in this section. Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corp. (Arrow Hart Division - formerly Cooper Industries)
 - 2. Bryant
 - 3. Hubbell Inc.
 - 4. Leviton MFG. Co., Inc.
 - 5. Pass & Seymour/Legrand

2.7 POKE-THRU DEVICES

- A. Provide all telecommunications and data plates in each poke-thru as specified and noted on Communications Drawings. See Section 26 05 34 for more information. Lid color to be bronze.
- B. Wiremold Evolution 8AT

2.8 POWER/DATA RACEWAY DEVICES

- A. Provide all telecommunications and data plates in power/data raceways as specified and noted on Communications Drawings. Devices to be compatible with power/data raceways as specified in Section 26 05 33.11.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Wall Switches:
 - 1. Install in a suitable outlet box on the strike side of the door.
 - 2. Mount at a height of 44" from the finished floor to the bottom of the switch.
 - 3. Position switches in a uniform position so that the same direction of operation will open and close the circuits throughout the job. Position up or to the left for the ON position.
 - 4. Do not install behind markerboards, millwork, permanent mounted equipment, etc. Verify on drawings before installation. Where installed in unsuitable location, the Contractor will move as directed at no cost to Owner.
 - 5. Prewired pigtail connectors that accommodate UL Fed Spec receptacles are approved for installation. P&S PlugTail or equal.
- B. Receptacles:
 - 1. Install in a suitable steel outlet box.
 - 2. Mount vertically at a height of 18 inches from the finished floor to the bottom of the receptacle or as shown on the drawings.
 - 3. The Architect can move any receptacle, before installation, up to 6 feet in any direction at no additional cost.
 - 4. Do not install behind markerboards, millwork, permanent mounted equipment, etc. Verify on Architectural drawings before installation. Where installed in unsuitable location, the Contractor will move as directed at no cost to Owner.
 - 5. Prewired pigtail connectors that accommodate UL Fed Spec receptacles are approved for installation. P&S PlugTail or equal.
- C. Tamper resistant receptacles: Provide tamper resistant outlets in the following spaces in accordance with 2017 NEC article 406.12.
 - 1. All spaces in preschool and elementary schools.
 - 2. Gyms, auditoriums, conference rooms, dining areas, and multipurpose rooms.
 - 3. All spaces in dormitories.
 - 4. All spaces in child care facilities.
 - 5. Offices, corridors, and waiting rooms of clinics, medical and dental offices, and outpatient facilities.
 - 6. Assembly areas of places of worship.
 - 7. Exceptions: Receptacle locations listed in the exceptions to 2017 NEC article 406.12 are not required to be tamper resistant.
- D. Device plates:
 - 1. Install device plates for each outlet box of the type required for service.
 - 2. Use a single one-piece device plate for ganged devices (switches & receptacle).
 - 3. Use separate device plates for dimmers, volume controls and electronic devices.
- E. Poke-Thru Devices:
 - 1. Provide and install all wiring, devices, covers, plates, conduit and hardware as required for a complete installation. Do not daisy-chain poke-thru devices with conduits unless otherwise noted on drawings.

2. Wiremold Evolution 8AT. Provide and install three duplex outlets and associated wiring per general notes on drawings. Provide isolated-ground outlets if indicated by symbol on drawings. Provide power to outlet using circuits shown on plans.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.1 SUMMARY

- A. This section supplements section 26 00 00 - Electrical and contains additional requirements applicable to fuses.

1.2 SECTION INCLUDES

- A. Low voltage fuses rated below 600 volts and 2000 amperes.

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 00 90 - Electrical Submittal Procedures

1.4 SUBMITTALS

- A. Submit product data for fuses in accordance with Section 26 00 90 Electrical Submittal Procedures.

1.5 QUALITY ASSURANCE

- A. Prior to ordering fuses or fuse holders, coordinate fuse ratings with the mechanical contractor to verify that fuses for HVAC equipment matches the MOCP values of the HVAC equipment being provided.

1.6 EXTRA MATERIALS

- A. Spare fuses: For each size and type fuse installed, provide to the owner at substantial completion six each or 10% of the quantity used on the project, whichever is less.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All fuses shall be from a single manufacturer. Products of the following manufacturers are acceptable.
 - 1. Bussman
 - 2. Littelfuse
 - 3. Mersen (formerly Ferraz Shawmut)

2.2 MANUFACTURED UNITS

- A. 600-amp and less: Class RK-1 dual element, time delay.
- B. 601-amp and larger: Class L or J

PART 3 EXECUTION

3.1 INSTALLATION

- A. Check fasteners on fuse clips for tightness when installing fuses.
- B. Install fuses so label is in an upright, readable position. Fuses without labels are not acceptable.
- C. Do not install fuses until equipment is ready to be energized.
- D. Fuse cabinet: For new buildings only, provide a fuse cabinet in the main electrical room. Cabinet to be lockable with depth equal to largest fuse provided. Minimum of 24" W x 24" H x 4" deep.

END OF SECTION

SECTION 26 28 16

ENCLOSED SAFETY SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

- A. Safety switches
- B. Disconnect Switches

1.1.2 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 00 90 - Electrical Submittal Procedures
- C. Section 26 05 53 - Electrical Identification
- D. Section 26 28 13 - Fuses
- E. Section 26 43 00 - Surge Protective Devices

1.2 REFERENCES

- A. ANSI/UL 98 - Safety Standard for Enclosed Switches.
- B. NEMA KS 1 - Enclosed Switches.

1.3 SYSTEM DESCRIPTION

- A. Safety switches shall be of the same manufacturer as distribution switchgear.
- B. The extent of safety switches, disconnect switches is indicated on the drawings and by the requirements of this section.
- C. In accordance with the service indicated, use 240 or 600 volt switches, single throw, fusible, or non-fusible, horsepower rated, 100% load break and make rated, designed for locking in "ON" or "OFF" position, in code gauge steel cabinets, as required by the application and the N.E.C.
- D. Use switches which have number of poles required, dependent on equipment requirements.
- E. Use NEMA 3R switches where exposed to weather, with weatherproof threaded hubs for top or side conduit entries into switch.
- F. Use fuse clips which are rejecting type to accept Class RK or L fuses only.
- G. Size fuses serving motor loads at 125% to 175% of motor nameplate rating, or the next standard size and as specifically recommended by motor or equipment manufacturer.

- H. Provide a manual switch at each motor, class 2510 Square D, for motors shown with "MS." Provide a 20-AMP rated switch at each motor not otherwise noted.

1.4 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.

1.5 PRODUCT DATA

- A. Submit product data for the following.
 - 1. Safety and Disconnect Switches

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. General Electric
- B. Square D
- C. Siemens
- D. Eaton Corporation (formerly Cutler-Hammer)

2.2 SWITCHES

- A. Provide safety switches and disconnects with a voltage rating suitable for the nominal voltage of the system in which they are to be applied. Contacts are quick-make, quick-break.
- B. Provide surge protective devices in accordance with section 26 43 00.

2.3 CONSTRUCTION

- A. Indoor dry locations, 30 amp thru 100 amp, use NEMA 1 general duty (GD).
- B. All outdoor locations use NEMA 3R heavy duty (HD).
- C. The handle shall be suitable for padlocking in the OFF position. Defeatable, front accessible, coin-proof door interlock to prevent opening the door when the switch is in the ON position and to prevent turning the switch ON when the door is open. Incoming line terminals with an insulated shield.
- D. Provide switches with rejection-type fuse holders suitable for use with fuses specified under Section 26 28 13.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mount switches no more than 6 inches above and within 6 feet of the equipment served at the direction of the Engineer, so that operating handle is easily accessible. Align tops of switches when grouped together.

- B. Mount vertically on required separate support system hardware with switch easily accessible (door to open 90 degrees minimum).
- C. Permanently mount safety switches from inside with plated or stainless bolts, toggle bolts or anchors.
- D. Exposed mounting bolts, screws, etc. are not acceptable.
- E. Permanently install fusible switches with class R fuse kits so that fuses are readable when looking at open switch.
- F. Do not mount switches/disconnects to access panels or on nameplate data or equipment.
- G. Installation of Conductors: Switches shall not be used as “junction boxes” between HVAC units (splicing or “pig tailing” is not permitted). The maximum number of conductors allowed per termination is determined by the manufacturer’s approved rating for each terminal or lug. Multiple conductor configurations shall be highlighted in the contractor’s submittal package. Exceptions to this rating must be obtained in writing from the engineer’s office on a case by case basis.
- H. Coordinate and verify exact fuse sizes with mechanical contractor. Fuses shown on drawings are based on one manufacturer. Fuse sizes vary depending on manufacturer.
- I. Identification: Refer to Section 26 05 53 for Electrical Identification. Provide name plate identification on all HVAC equipment regardless of equipment location.

END OF SECTION

SECTION 26 28 19

GROUND FAULT PROTECTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

- A. Ground fault protection systems

1.1.2 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Division 26, Section 26 00 00, apply to this Section.
 - 1. Section 26 00 00 - Electrical
 - 2. Section 26 24 16 - Panelboards
 - 3. Section 26 21 00 - Low Voltage Electrical Service Entrance

1.2 REFERENCES

- A. NEC: 100, 230-95, 517-17, 700-27
- B. UL: E51827
- C. All other governing local codes.

1.3 SUBMITTALS

- A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.

1.4 PRODUCT DATA

- A. Submit product data for the following:
 - 1. Procedure for testing system performance as required by the NEC.
 - 2. Operating procedures, schematics and wiring diagrams.
 - 3. Calibration for current pickup adjustment and recommended settings for current pickup and delay adjustments.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Refer to specification section 26 24 16 – Panelboards for approved manufacturers.

2.2 EQUIPMENT

- A. Ground Fault Protection System:
 - 1. Ground sensor relay (GSR) system with ground break components, solid state construction, adjustable current pick-up and time delay settings.

2. Coordinate ground sensor (CT) with integral test winding of sufficient size to encircle all phase and neutral conductors, for zero sequence monitoring and a solid state relay to operate the trip circuit on the main switches.
 3. Provide required transformer to supply power for tripping switches and connect phase to phase.
- B. Accessories Included:
1. Ground fault relaying system for main switches to be zero-sequence type.
 2. Ground fault current-detection range to be 100 to 1,200 amperes.
 3. Time delay range to be instantaneous to 60 cycles.
 4. Derive tripping and control power from control power transformers in switchboard.
 5. Components shall include static ground fault sensor, current monitor, and test panel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide ground fault protection at all service entrance equipment in accordance with 2014 NEC 230.95 Ground Fault Protection of Equipment.
- B. At health care facilities, provide an additional level of ground fault protection in accordance with 2014 NEC 517.17 Ground Fault Protection.
- C. Provide ground fault sensing and indication on emergency systems in accordance with 2014 NEC 700.27 Ground Fault Protection of Equipment.
- D. Provide ground fault protection at any additional locations indicated on the drawings.

3.2 SITE TESTS, INSPECTION

- A. Manufacturer to test for required calibration after switchgear is in operation but before final acceptance.
- B. Provide written documentation of manufacturer's testing and calibration to the Engineer before final acceptance of project.
- C. Setting shall be coordinated with the Power Company.
 1. Initial settings: At the time of installation, adjust the settings of the ground fault protection device as follows:
 - a. Time delay: Adjust the time delay to 0.3 seconds.
 - b. Pick-up: In no case can the setting exceed 1,200 amps. Observing this absolute maximum, adjust the ground fault trip setting to the greater of the following two options.
 - (1) 15% of the trip rating of the main breaker in the service entrance equipment.
 - (2) At least as large as the trip rating of the largest downstream overcurrent device that serves a single piece of equipment.

END OF SECTION

SECTION 26 43 00

SURGE PROTECTIVE DEVICES (SPD)

PART 1 GENERAL

1.1 SUMMARY

- A. This section supplements section 26 00 00 Electrical and contains additional requirements applicable to surge protective devices.

1.2 SECTION INCLUDES

- A. Surge protective devices (SPD) provided in accordance with NEC article 285.
- B. SPD for phone, data, security and other systems.

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 00 90 - Electrical Submittal Procedures

1.4 REFERENCES

- A. NEC - NFPA 70 National Electrical Code, most current edition
- B. UL 1449 - Underwriters Laboratories, UL 1449, Standard for Safety, Surge Protection Devices 4th Edition March 2016 Type 1, Type 2 and Type 3 Protectors
- C. ANSI/IEEE C62: Complete C62: Complete 1990 Edition: Guides and Standards for Surge Protection
- D. UL 497 Paired Conductor Communications Circuits

1.5 SUBMITTALS

- A. Submit in accordance with Section 26 00 90 Electrical Submittal Procedures.
- B. Product Data: Submit product data for all SPD used on this project. Provide evidence that SPD are listed to the most current edition of UL1449 by an OSHA approved safety testing agency (i.e. UL, ETL, or CSA). Provide a submittal package that includes specifications and 3rd party testing and listing letters.

1.6 WARRANTY

- A. All surge suppression devices and supporting components shall be guaranteed by the installing contractor to be free of defects in materials and workmanship for a period of five years minimum excluding installation labor. Lightning damage to the SPD is not grounds for voiding any/all warranties of the SPD.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following.
1. ACT Communications
 2. Eaton Corporation (formerly Cutler Hammer)
 3. Emerson – Liebert
 4. GE Industrial
 5. Mersen (formerly Ferraz Shawmut)
 6. Schneider Electric – Square D

2.2 MANUFACTURED UNITS

- A. Technology: Construction shall be metal oxide varister (MOV) componentry with bidirectional operation.
- B. Protection Modes: Provide at least seven mode protection (L-N, L-G, N-G) with discrete protection elements on each mode.
- C. Protection: Each SPD shall be protected upstream by a dedicated UL rated fuse or disconnecting means.
- D. Filtering: Provide surge protection plus filtering of disruptive noises, EMI/RFI interference to >-40db from 3kHz to 1 MHz according to NEMA LS-1 Specification.
- E. Listing and ratings: SPD shall be tested and performance rated per UL1449. Clamping voltage shall be clearly stated on both submittals and equipment installed.
- F. Voltage ratings:

Rated Line Voltage	Maximum Continuous Operating Voltage (MCOV)	Voltage Protection Rating (VPR)
120/240; 120/208 volt	150 volts	700 volts (L-N, L-G), 1000 (L-L)
240/480; 277/480 volt	320 volts	1000 volts (L-N, L-G), 1800 (L-L)
480 volts (2 ph. Delta)	600 volts	1800 volts (L-N, L-G), 3000 (L-L)

- G. Alarms and monitoring: Provide SPD with the following.
1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. One set of dry contacts rated at 5A and 240V for remote monitoring of protection.
- H. SPD at the electrical service entrance shall meet the following additional criteria.
1. Modular construction and field replaceable.
 2. Bus Bar connected for low impedance connections.
 3. UL rated as Type 1 and Type 2 SPD device
 4. SCCR: 200kAIC
 5. Nominal Discharge Current: 20,000 amperes (8x20 us- waveform)
 6. Maximum Single Impulse Current rating: >135,000 amperes (8 X 20 us waveform) / mode.
 7. Repetitive Surge testing per IEEE C62.41.2 C3 10,000 amps: 20,000 impulses
- I. SPD at electrical sub-panels shall meet the following additional criteria.
1. Modular or System construction

2. UL rated as Type 2 device
 3. SCCR: 100kAIC or no less than specified rating of the electrical subpanel.
 4. Nominal Discharge Current: 10,000 amperes (8x20 us- waveform)
 5. Maximum Single Impulse Current rating: >65,000 amperes (8 X 20 us waveform) / mode.
 6. Repetitive Surge testing per IEEE C62.41.2 C3 10,000 amps: >2,500 impulses
- J. SPD at rooftop units and condensers shall meet the following additional criteria.
1. NEMA 4X enclosure suitable for outdoor installation
 2. Nipple-mounted
 3. SCCR: 100kAIC
 4. Squared D SDSA series or equivalent.
- K. Receptacles with Type 3 SPD installed – Use only when one or two outlets need SPD and panel is not readily available:
1. SPD in a receptacle is able to employ a maximum of two IEC 320 receptacles (NEMA 5-20R) and shall be rated not more than the current rating of the SPD and voltage rating consistent with the voltage rating of the SPD.
 2. A SPD receptacle used for outdoor use shall comply with the outdoor requirements in UL 498 and shall be provided with a receptacle hood which is weather-proof.
 3. Permanently wired with high visibility LED indicator and/or damage alert beeper
 4. Minimum Transient Suppression:
 - a. MCOV and VPR matches section 2.2 B 4
 - b. 6,500 amp peak current in each mode
 5. Manufacturers:
 - a. Pass and Seymour 6262 Series
 - b. Hubbell 8200 H Series
 - c. Leviton 5300 Series
 - d. Wiremold "Sentrex 52TB2" series
- L. SPD for telephone, video, data and alarm lines shall meet the following criteria.
1. Comply with appropriate UL 497, 497A, 497B and 497C standards for secondary protectors.
 2. Technology can be Gas Tube, Silicon Avalanche Diode or hybrid.
 3. Rate Line Voltage (RMS): 150V for phone, 24V for data and control.
 4. Maximum single line impulse 10,000 amps (8/20 us current waveform).
 5. Clamp Voltage (Pair): Tip to ground and Ring to ground: 300 volts
 6. Pulse Life: 1,000 - 3KA - 8/20 NS impulse with drift.
 7. Maximum Continuous Operating Voltage: 180 VAC tip to ground, 180 VAC ring to ground

PART 3 EXECUTION

3.1 INSTALLATION

- A. For new construction, provide SPD at each of the following locations. For renovations and additions, provide SPD at the following locations which are affected by the project but do not already have SPD.
1. Each electrical service entrance equipment.
 2. Each main computer panelboard and at each isolated ground panelboard.
 3. At all emergency systems switchboards and panelboards.
 4. At each panelboard noted on drawings in addition to above requirements.
 5. On all outdoor rooftop HVAC units and on all condensing unit switches. Mount to bottom of switch or as recommended by the manufacturer.
 6. One SPD power outlet at each energy management control panel located by project controls contractor.

7. At each new telephone and data incoming line.
8. On all new video or alarm system wire entering from the outside of the facility.
9. In or on each fire pump controller in accordance with NEC 2017 Article 695.15.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section supplements section 26 00 00 - Electrical and contains additional requirements applicable to all lighting systems.

1.2 SECTION INCLUDES

- A. Interior and exterior lighting systems, with the exception of sports lighting and theatrical lighting.
- B. Luminaires, lamps, ballasts, LED drivers, emergency battery packs, emergency power transfer devices.

1.3 RELATED SECTIONS

- A. Section 26 00 00 - Electrical
- B. Section 26 00 90 - Electrical Submittal Procedures
- C. Section 26 09 16 - Time Switches
- D. Section 26 09 41 - Lighting Controls

1.4 REFERENCES

- A. Energy Star
- B. DLC - DesignLights™ Consortium
- C. TCLP - Federal Toxicity Characteristic Leaching Procedure
- D. UL 1598 - Safety Standard for Luminaires
- E. ANSI/UL 844 - Safety Standard for Electric Lighting Fixture for Use in Hazardous Locations
- F. ANSI C78.377 - Specification for the Chromaticity of Solid State Lighting Products
- G. ANSI/UL 1029 - Safety Standard for High Intensity Discharge Lamp Ballasts
- H. NECA/IESNA 500 (2006) - Recommended Practice for Installing Indoor Commercial Lighting Systems
- I. NECA/IESNA 501 (2006) - Recommended Practice for Installing Exterior Lighting Systems
- J. UL 8750 - Safety Standard for LED Equipment for Use in Lighting Products
- K. UL 924 - Standard for Emergency Lighting and Power Equipment
- L. UL 935 - Safety Standard for Fluorescent-Lamp Ballasts

- M. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
- N. LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources
- O. TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources

1.5 PERFORMANCE REQUIREMENTS

- A. All lighting systems shall be compatible with lighting controls shown on the drawings or specified in 26 09 16 - Time Switches and/or 26 09 41 – Lighting Controls.
- B. To meet the enhanced digital lighting controls option of IECC 2015, all luminaires shall be digitally addressable through the lighting control system. Refer to 26 09 41, Lighting Controls, for additional requirements.

1.6 SUBMITTALS

- A. Submit in accordance with Section 26 00 90 - Electrical Submittal Procedures.

1.7 PRODUCT DATA

- A. Submit complete product information for the following:
 - 1. Luminaires
 - 2. Lamps
 - 3. Ballasts
 - 4. LED drivers
 - 5. Battery backup units
 - 6. Automatic transfer devices for emergency lighting
 - 7. Product warranty documentation
- B. Submit luminaires shown on the Luminaire Schedule on the drawings and those noted on the drawings but not on the schedule.
- C. Include complete manufacturer's part numbers.
- D. Clearly highlight or otherwise indicate on the cut sheets all options and accessories.
- E. Indicate if [DLC](#) listing applies only to certain color temperatures, beam spreads, or other luminaire options. Indicate if any luminaire options void the DLC listing.
- F. Indicate the L70 rating and the number of LM-80 testing hours for all LED luminaires.

1.8 SAMPLES

- A. Submit non-returnable samples of fixtures upon request. Include all lamps and ballasts.

1.9 QUALITY ASSURANCE/CONTROL SUBMITTALS

- A. This project may require compliance with the Windstorm Inspection Program of the Texas Department of Insurance (TDI). Refer to Division 01 specifications to determine whether windstorm certification is required, and for submittal requirements of the TDI Windstorm Inspection Program.

1.10 CLOSEOUT SUBMITTALS

- A. Provide owner a list of all luminaire types used on the project using manufacturer part numbers.
- B. Provide owner a list of all ballast types and lamp types used on the project using ANSI and manufacturer codes.
- C. Provide owner a list of battery backup, automatic transfer devices, etc. on the project using manufacturer part numbers. Provide on as-built drawings the location of all remote-mounted battery backups.

1.11 QUALIFICATIONS

- A. All luminaires shall be from manufacturers who has been regularly engaged in the production of such products for the past five years.

1.12 REGULATORY REQUIREMENTS

- A. All luminaires and components, including lamps, ballasts, emergency battery packs, transfer devices, LED modules and drivers shall be UL listed.
- B. This project may require compliance with the Windstorm Inspection Program of the Texas Department of Insurance (TDI). Refer to Division 01 specifications to determine whether windstorm certification is required, and for requirements of the TDI Windstorm Inspection Program.

1.13 STORAGE AND PROTECTION

- A. Store all product in accordance with manufacturer's storage requirements.

1.14 SPECIAL WARRANTY

- A. Provide a 1 year manufacturer's warranty for all fluorescent and HID luminaires.
- B. Provide a 5 year manufacturer's warranty for all LED luminaires. The warranty shall include all luminaire components including, but not limited to, LED arrays, LED drivers, luminaire body and hardware. LED arrays will be considered defective if a total of 15% or more of the individual light emitting diodes fail to illuminate.
- C. Provide a 1 year manufacturer's warranty for all lamps.
- D. Provide a nominal 5 year (25,000 burn hours over 60 months) manufacturer's warranty for all ballasts.
- E. Provide a 5 year manufacturer's full warranty for all battery packs.
- F. The warranties shall cover the cost of materials and labor for repair and installation.

1.15 EXTRA MATERIALS

- A. Provide the following to the owner at or before final acceptance.
 - 1. Ten of each main HID ballast, or 10% of the quantity used on the project, whichever is less.
 - 2. Twenty of each main fluorescent ballast, or 10% of the quantity used on the project, whichever is less.

3. Twelve of each biax ballast, or 10% of the quantity used on the project, whichever is less.
 4. Ten of each main HID lamp, or 10% of the quantity used on the project, whichever is less.
 5. Four cases of each 2', 3', and 4' lamp used, or 10% of the quantity used on the project, whichever is less.
 6. Two standard packages of each biax lamp used, or 10% of the quantity used on the project, whichever is less.
- B. Extra materials are not in lieu of product warranty replacement.
- C. Provide documented proof with close-out documents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Only those manufacturers of luminaires, lamps, and ballasts listed on the Luminaire Schedule or listed in the specifications are acceptable.
- B. Provide lamps from one manufacturer, unless otherwise required.
- C. Provide ballasts from one manufacturer, unless otherwise required.
- D. Accepted ballast manufacturers:
1. Osram Sylvania
 2. General Electric
 3. Philips Advance
 4. Universal
- E. Accepted lamp manufacturers:
1. Osram Sylvania
 2. General Electric
 3. Philips

2.2 EXISTING PRODUCTS

- A. New luminaires must match existing luminaires in all areas including but not limited to style, color, orientation, mounting height, ballast and lamp type, switching capability, voltage, etc. The new luminaires must meet or exceed the quality of the existing luminaires and must meet all current codes and standards for efficiency.
- B. New lamps and ballasts must match existing lamps and ballasts regarding manufacturer and operation. The new lamps and ballasts must meet or exceed the quality of the existing lamps and ballasts, and must meet all current codes and standards for efficiency.

2.3 LUMINAIRES

- A. The following requirements apply to all luminaires. See following articles for additional requirements for specific types of luminaires.
- B. Only those products listed on the Luminaire Schedule or noted in the drawings are acceptable.
- C. Unless otherwise noted, consult architect for luminaire color or finish.
- D. All fluorescent and HID luminaires shall comply with UL 1598 requirements and be UL listed.

- E. All luminaires used in hazardous locations shall comply with UL 844 requirements and be UL listed.
- F. All luminaires used for emergency lighting, including exit lights, shall be UL 924 listed.

2.4 LED LUMINAIRES

- A. LED luminaires shall meet the following requirements in addition to the general requirements for luminaires listed above.
- B. All LED luminaires shall comply with UL 8750 requirements and be UL listed.
- C. All LED general purpose luminaires shall be either Energy Star or DLC approved.
- D. Expected Life: All LED luminaires shall have a minimum L70 of 50,000 hours. The estimated L70 of LED luminaires shall be derived from LM-80 test data in accordance with [TM-21](#) procedures. LM-80 test data shall be measured in accordance with LM-79 procedures.
- E. Color rendering: All interior LED luminaires shall have a minimum CRI of 82. All exterior LED luminaires shall have a minimum CRI of 70.
- F. Color temperature: Unless specified to the contrary, all LED luminaires on the same project are to have the same correlated color temperature (CCT). See the Luminaire Schedule for LED CCT. LED luminaire CCT shall be within a 3-step SCDM (Standard Deviation Color Matching) in accordance with ANSI C78.377.
- G. Maximum power: The maximum power input of all LED luminaires shall be as indicated on the Luminaire Schedule, with a tolerance of +5% / -10%.
- H. Efficacy: All general purpose LED luminaires shall have a minimum efficacy of 90 lumens/watt.
- I. Lumen output: The lumen output of all LED luminaires shall be as indicated on the Luminaire Schedule, with a tolerance of plus or minus 8%.

2.5 LOW BAY AND HIGH BAY HID LUMINAIRES

- A. Low bay and High Bay HID luminaires shall meet the following requirements in addition to the general requirements for luminaires listed above.
- B. Housing and reflector of low bay and high bay HID luminaires shall be made of borosilicate glass, UV-stabilized clear acrylic, or aluminum.
- C. HID luminaires in gymnasium play areas shall have safety hooks and shall have twist lock cord & plug connection. Safety hooks shall be provided with safety screws or other positive mechanical means to prevent the hooks from being dislodged.
- D. All HID luminaires located in gyms, play areas, multipurpose spaces, etc. shall have a lens and wire guard.
- E. Lens or wire guard for low bay and high bay HID luminaires shall be hinged and shall have retainer latches for tool-less maintenance.

2.6 HIGH BAY FLUORESCENT AND LED LUMINAIRES

- A. Fluorescent high bay luminaires shall meet the following requirements in addition to the general requirements for luminaires listed above. LED high bay luminaires shall meet the following requirements in addition to the requirements for LED luminaires listed above.
- B. All high bay luminaires located in gyms, play areas, multipurpose spaces, etc. shall have a wire guard.
- C. Lens, if provided, or wire guard of high bay luminaires shall be hinged and shall have retainer latches for tool-less maintenance.

2.7 EXIT SIGNS

- A. LED exit signs shall also meet the following requirements in addition to the general requirements for LED luminaires.
- B. LED exit signs shall be rated for at least 10 years unless otherwise noted.
- C. LED exit signs shall be provided with maintenance free batteries good for at least 90 minutes.
- D. LED exit signs shall be provided with status indicator lamp and test switch.
- E. Powered LED exit signs shall be UL tested and approved with 100' visibility.
- F. Non-LED self-luminous exit signs shall be good for at least 20 years and shall be UL tested and approved with 100' visibility.
- G. Exit signs in gyms shall have a wire guard.

2.8 POLE-MOUNTED EXTERIOR LUMINAIRES

- A. Pole-mounted exterior luminaires shall meet the following requirements in addition to the requirements listed above in the Luminaires article. LED pole-mounted luminaires shall meet the following requirements in addition to the requirements listed above in the LED Luminaires article.
- B. Lamp sockets of pole mounted HID luminaires shall be rated for at least 600w.
- C. Pole mounted luminaires shall have an option for internal glare control or external glare shield where applicable.
- D. All exterior surfaces of pole mounted luminaires shall be painted using powder coat finish.
- E. See section 26 56 23 - Area Lighting for additional site lighting requirements, including poles.

2.9 LAMPS

- A. The following requirements apply to all lamps. See following articles for additional requirements for specific types of lamps.
- B. Ballast compatibility: Lamps shall match the ballast starting type.
- C. All lamps shall pass the TCLP criteria for classification as non-hazardous waste.

2.10 FLUORESCENT LAMPS

- A. Fluorescent lamps shall meet the following requirements in addition to the general requirements for lamps listed above.
- B. Unless specified to the contrary, all fluorescent and compact fluorescent lamps on the same project are to have the same correlated color temperature (CCT). See the Luminaire Schedule for lamp CCT.
- C. All fluorescent lamps installed in open luminaires shall be coated or sleeved (from the factory) if installed in a kitchen, concessions, or other areas around food.
- D. Provide fluorescent lamps with a minimum CRI of 82.
- E. Provide fluorescent lamps with a minimum lumen maintenance of 94%.
- F. T8 fluorescent lamps shall have a minimum rated lamp life of 30,000 hours based on 12 hours of operation per start.
- G. T5 and T5HO fluorescent lamps shall have a minimum rated lamp life of 36,000 hours based on 12 hours of operation per start.
- H. Provide compact fluorescent (CFL) lamps with 10mm tube diameter in wattages up to 26 watt and 15mm diameter in wattages from 38 watts to 50 watts.
- I. CFL lamps shall have a minimum rated lamp life of 12,000 hours based on 12 hours of operation per start.

2.11 HID LAMPS

- A. HID lamps shall meet the following requirements in addition to the general requirements for lamps listed above.
- B. Burning position: The burning position of HID lamps shall match luminaire orientation and meet lamp manufacturer's specifications.
- C. Unless specified to the contrary, all HID lamps on the same project are to have the same correlated color temperature (CCT).
- D. All HID lamps installed in open luminaires shall be protected lamps.
- E. All HID lamps shall be clear unless otherwise noted.

2.12 METAL HALIDE LAMPS

- A. Metal Halide lamps shall meet the following requirements in addition to the requirements for HID lamps listed above.
- B. Provide metal halide lamps with a minimum CRI of 65.
- C. See Luminaire Schedule for lamp CCT. If it is not listed there, provide a CCT of 4100k.
- D. Metal halide lamps shall meet the following criteria for minimum lamp life and minimum initial lumens.

PART DESCRIPTION	PART NUMBER	LAMP LIFE (HRS)	MIN. INITIAL LUMENS
50w PS	MP50/U/MED	10k	1900
70w PS	MP70/U/MED	10k	3400
100w PS	MP100/U/MED	10k	5525
150w PS	MP150/U/MED	10k	8800
175w	MP175	10k	10200
175w PS	MS175/PS	15k	12800
200w PS	MS200/PS	15k	13300
250w	MP250	10k	17000
250w PS	MP250/PS	15k	17000
320w PS	MS320/PS	15K	21000
350w PS	MP350/PS	20K	24500
400w	MP400	15K	20500
400w SMH	MS400	20K	26000
400w PS	MS400/PS	20K	31000
750w PS	MS750/PS	12K	51000
1000w	M1000/U	12K	86300
1000w SMH	MS1000	18K	92000
1000w PS	M1000/PS	9K	86300
1500w	M1500	3K	127400

2.13 HIGH PRESSURE SODIUM (HPS) LAMPS

- A. HPS lamps shall meet the following requirements in addition to the general requirements for HID lamps listed above.
- B. Provide HPS lamps with a minimum CRI of 82.
- C. See Luminaire Schedule for lamp CCT. If it is not listed there, provide a CCT of 2100k.
- D. Provide HPS lamps with a minimum Lumen Maintenance of 94%.
- E. HPS lamps shall meet the following criteria for minimum lamp life and minimum initial lumens.

PART DESCRIPTION	PART NUMBER	LAMP LIFE (HRS)	MIN. MEAN LUMENS
35w	LU35/MED	16K	2050
50w	LU50/MED	24K	3600
70w	LU70/MED	24K	5350
100w	LU100/MED	24K	8000
150w	LU150/MED	24K	12500
200w	LU200/ECO	24K	19800
250w	LU250/ECO	24K	26100
400w	LU400/ECO	24K	45000
750W	LU750	24K	94500
1000W	LU1000	24K	124000

2.14 BALLASTS

- A. The following requirements apply to all ballasts. See following articles for additional requirements for specific types of ballasts

- B. Input power: Ballast input wattage for the supplied ballast must be the same or less than the input wattage listed on the Luminaire Schedule.
- C. Ballast factor: The ballast factor for the supplied ballast must be the same or greater than the ballast factor of the ballast listed in the Luminaire Schedule.
- D. Voltage: Ballasts shall be 60 Hz, universal input voltage (120V – 277V) +/- 10% unless otherwise indicated in the Luminaire Schedule.
- E. Remote ballasts: Remote ballasts shall have remote wiring capability of up to 20 feet.
- F. Lamp compatibility: Ballasts shall provide lamp starting conditions and operating parameters consistent with lamp manufacturer's recommendations and shall be suitable for the luminaire operating conditions.
- G. Wiring Diagrams: Ballasts shall have wiring diagrams and lamp connections displayed on the ballast.
- H. Sensor compatibility: Ballasts shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems.
- I. Sound rating: Ballasts shall have a Class "A" sound rating.
- J. Ballasts shall be CBM-ETL certified, UL Class P, and bear such labels.

2.15 FLUORESCENT BALLASTS

- A. Fluorescent ballasts shall meet the following requirements in addition to the general requirements for ballasts listed above.
- B. Fluorescent ballasts shall comply with UL 935 and be UL listed.
- C. Fluorescent ballasts shall comply with FCC - 47CFR Part 18 Non-Consumer for EMI/RFI interference.
- D. Power factor: Fluorescent ballasts shall have a power factor of 0.97 or greater.
- E. Total harmonic distortion (THD): Fluorescent ballasts shall be 10% THD or less.
- F. Enclosure Temperature: Fluorescent ballasts shall have a maximum enclosure temperature rating of 70°C.
- G. High Frequency: Fluorescent ballasts shall be high frequency electronic type, operating at a frequency between 42 kHz and 46 kHz.
- H. Tandem wiring: Multiple luminaires shall not share a common ballast (no tandem wiring).

2.16 T8 BALLASTS

- A. T8 ballasts shall meet the following requirements in addition to the requirements for fluorescent ballasts listed above.
- B. Ballast type: T8 ballasts shall be program rapid start type unless indicated otherwise on the Luminaire Schedule.
- C. Instant start ballasts shall be parallel circuit wired.

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE			
		1 LP	2 LP	3 LP	4 LP
I.S. HIGH EFFICIENCY	0.88	28	55	83	108
I.S. HIGH EFF. LOW POWER	0.78	25	48	71	95
PROGRAM R.S. (STANDARD)	0.88	31	59	88	118
PROGRAM R.S. LOW POWER	0.87	28	55	82	109
PROGRAM R.S. DIMMING	0.88	30	60	87	114

2.17 T5 & T5HO BALLASTS

- A. T5 and T5HO ballasts shall meet the following requirements in addition to the requirements for fluorescent ballasts listed above.
- B. Ballast type: T5 and T5HO ballasts shall be program rapid start type.
- C. End of life: Ballasts for T5 and smaller diameters shall have end of life (EOL) sensing in accordance with NEMA C78.81 and NEMA C78.901 as applicable.

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE	
		1 LP	2 LP
ALL T5	1.0	32	65
ALL T5HO	1.0	62	121

2.18 COMPACT FLUORESCENT BALLASTS

- A. CFL ballasts shall meet the following requirements in addition to the requirements for fluorescent ballasts listed above.
- B. Ballast type: Compact fluorescent ballasts shall be program rapid start type unless indicated otherwise on the Luminaire Schedule.
- C. Compact fluorescent ballasts for lamps thru 13 watt shall be encapsulated, full light output and pre-heat start.
- D. Compact fluorescent ballasts for lamps 18 watt thru 55 watt shall be 4 pin base, full light output. Equal to Advance "Standard", "Centium", "Mark V".

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE	
		1 LP	2 LP
13W CF	1.0	16	29
18W CF	1.0	20	38
26W DOUBLE TUBE CF	1.0	28	54
26W TRIPLE TUBE CF	1.0	28	54
32W TRIPLE TUBE CF	.98	35	69
42W TRIPLE TUBE CF	.95	45	94

2.19 HID BALLASTS

- A. HID ballasts shall meet the following requirements in addition to the general requirements for ballasts listed above.
- B. HID ballasts shall comply with UL 1029 and be UL listed.
- C. Total harmonic distortion (THD): Magnetic HID ballasts shall be 33% THD or less and electronic HID ballasts shall be 15% THD or less.
- D. Power factor: HID ballasts shall be high power factor of 90% or greater.
- E. Operating temperature range: Outdoor HID ballasts shall be enclosed in a weatherproof housing and rated to operate to a temperature of minus 20°F.

2.20 MAGNETIC HID BALLASTS

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE
250W MH	1.0	290
400W MH	1.0	458
1000W MH	1.0	1080
1500W MH	1.0	1605

2.21 PULSE START MAGNETIC HID BALLASTS

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE
39W PMH	1.0	58
50W PMH	1.0	67
70W PMH	1.0	95
100W PMH	1.0	130
150W PMH	1.0	185
175W PMH	1.0	208
250W PMH	1.0	288
320W PMH	1.0	368
350W PMH	1.0	400
400W PMH	1.0	452
450W PMH	1.0	508
750W PMH	1.0	818
1000W PMH	1.0	1080

2.22 ELECTRONIC HID BALLASTS

- A. Electronic HID ballasts shall operate only one lamp unless specifically called out on the Luminaire Schedule or on the plans.

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE
20W PMH	1.0	23
39W PMH	1.0	44
50W PMH	1.0	

BALLAST DESCRIPTION	MIN. BALLAST FACTOR	MAX. BALLAST WATTAGE
70W PMH	1.0	79
100W PMH	1.0	110
150W PMH	1.0	167
175W PMH	1.0	
250W PMH	1.0	269
320W PMH	1.0	344
350W PMH	1.0	376
400W PMH	1.0	430

2.23 ACCESSORIES

- A. Lenses: Lenses for fluorescent and LED troffers shall be 100% virgin acrylic and have a nominal thickness of 0.125 inch.
- B. Emergency Battery Packs: Emergency battery packs shall be factory installed. All emergency luminaire troffers shall operate at 1400 lumen or greater output for at least 90 minutes. All battery backups installed in exterior luminaires shall be rated for damp location and rated to operate at 32°F.

PART 3 EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

- A. Field verify existing conditions to determine luminaire quantities, spacing, location, orientation, mounting height, input voltage, color, switching arrangement, etc. to install in each space to properly serve the switching arrangement, lamp type, lamp quantity, voltage, feeder condition, etc. of existing luminaires to be replaced or added to. All replacement luminaires shall match these physical characteristics or the standard outlined in this specification, whichever is greater.

3.2 INSTALLATION

- A. Provide all luminaires of the types indicated, in accordance with NEMA standards, manufacturer's recommendations, and NEC requirements.
- B. Install indoor lighting systems in accordance with NECA/IESNA-500.
- C. Install exterior lighting systems in accordance with NECA/IESNA-501.
- D. Provide luminaires complete with lamps, ballasts, LED arrays, LED drivers, and other accessories necessary for proper installation in the building construction and listed for fire rated ceilings where required by code.
- E. Lighting control: Provide switches with matching technology (Mark VII, Mark X, etc.) for dimming ballasts in the locations shown on the drawings. Provide lighting controls in accordance with sections 26 09 16 - Time Switches and/or 26 09 41 – Lighting Controls.
- F. Emergency lighting: Provide a battery backup, transfer switch, internal wiring etc. in each luminaire indicated as an emergency luminaire or night light. If a type designation is omitted from an emergency luminaire then furnish a battery backup or automatic transfer device in the standard luminaire and make it an emergency luminaire. If the unswitched hot leg needed for

proper operation does not exist, provide a new unswitched hot leg to the luminaire as needed for proper operation. The unswitched hot wire must come from the same branch circuit that powers the luminaire.

- G. Verify that the specified luminaires are compatible with the specified ceiling systems as indicated on the Architectural drawings. Advise the Architect/Engineer of any discrepancies before placing the luminaire order.
- H. Locate luminaires in mechanical and other similar equipment rooms to clear all obstructions. Obtain approval from the architect or engineer before placing luminaires where the location as shown on the drawings must be radically changed.
- I. Support surface mounted luminaires from the building structure with a minimum of two 1/4 inch threaded rods per fixture. Use 1½ inch x 1½ inch steel framing channel where required to span joists and otherwise facilitate structural support.
- J. Mount recessed luminaires in the center of a ceiling tile or as shown on the drawings. Provide support for recessed luminaires by means of bar hangers extended across the main ceiling support members and also supported from the building structure.
- K. Run fixture whips (flex conduit/metal clad cable) from a junction box to each fixture (not to exceed four fixtures per junction box) access plate. Fixture whips between light fixtures will not be accepted. Whips shall not be more than 6'-0" in total length.
- L. Provide remote mounted ballasts for any HID luminaire used in a library or other space where sound is a concern.
- M. Locate all remote ballasts above the ceiling above each luminaire or in an adjacent room with a low ceiling for easy access. Mount ballasts on rubber insulators.
- N. Exit signs: Exit signs are not to be switched.
- O. HID Burn-in: Burn-in all HID lamps 100 hours before occupancy by owner or tenant. All HID lamps intended to be dimmed must be burned in for at least 100 hours at full voltage before being dimmed.
- P. Prior to final inspection, check all luminaires for damages during construction and replace damaged luminaires at no additional expense to the Owner. Test all emergency luminaires for proper operation, including exercising all transfer switching, battery backups, generator, etc. All luminaires shall be cleaned and completely lamped at the time of final acceptance of the building.

3.3 REPAIR/RESTORATION

- A. Some or all luminaires on this project are to be repaired. Verify existing conditions and repair or restore existing conditions to like new condition by replacing all lamps, replacing all ballasts, cleaning luminaires, etc. See drawings for extent of work.

3.4 ADJUSTING

- A. Move any luminaire up to six feet in any direction as directed at no additional cost.

END OF SECTION

SECTION 27 0526

GROUNDING AND BONDING FOR COMMUNICATIONS 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. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding rods.
 - 5. Grounding labeling.

1.3 DEFINITIONS

- A. AC: Alternating current.
- B. BCT: Bonding conductor for telecommunications.
- C. TGB: Telecommunications grounding busbar.
- D. TMGB: Telecommunications main grounding busbar.
- E. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

- A. Bidding Contractor is invited to submit bids for the structured cable solution if Contractor meets the certification and other requirements detailed below.
- B. Product Data: For each type of product.
- C. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 — Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 — Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 - 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 - 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- D. Section 3 — Pre-Qualification Certificate
 - 1. Contractor will submit the following documents with project proposal:
 - 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 - 3. Training certificates for design, engineering and installation of the proposed products.
- E. Section 4 — Warranty Documentation
 - 1. Warranty will be for life of the installed product.
 - 2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
- F. Section 5 — Record Drawings
 - 1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
 - 2. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 3. Ground rods.
 - 4. Ground and roof rings.
 - 5. BCT, TMGB, TGBs, and routing of their bonding conductors
 - 6. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

- G. Qualification Data: For testing agency and testing agency's field supervisor.
- H. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.
 - c. Provide final test reports upon project completion per Section 3.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as an RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-B.

2.2 CONDUCTORS

- A. Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Panduit (preferred), Chatsworth, or Bline
- B. Comply with UL 486A-486B.

- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
- D. Cable Tray Grounding Jumper:
 - 1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
 - 2. Not smaller than No. 10 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
- E. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- F. Grounding Conductor from Busbar to equipment
 - 1. The SCS Contractor will provide a #6 AWG stranded copper wire cable insulated with a green jacket between the ground bars located at the MDF and the IDF and the equipment, termination, equipment rack, ladder and computer equipment grounding points using proper end attachment hardware.
 - 2. SCS Contractor shall attach grounding cable to appropriate end connecting hardware using manufacturer-approved materials and methods.
- G. Bonding and Grounding
 - 1. Communication bonding and grounding will be in accordance with the NEC and NFPA.
 - 2. Horizontal cables and equipment will be grounded in compliance with ANSI/NFPA 70 and local requirements and practices.
 - a. Horizontal equipment includes cross connect frames, patch panels and racks, cable support ladder rack, active telecommunication equipment and test apparatus and equipment.
- H. Telecommunications Bonding Backbone
 - 1. The Electrical Contractor will provide a Telecommunications Bonding Backbone between the TMGB and both an approved building ground (structure) and an approved panel ground. The Electrical Contractor will repeat this action for each IDF room TGB.
 - a. Electrical will size the grounding backbone as per the NEC and the measured distance from the ground bar to the building ground and to the panel ground.

2. Telecommunications Bonding Backbone shall be in compliance with NEC Article 250 and ANSI/TIA-607.
3. Always provide Telecommunications Bonding Backbone when using non-shielded backbone copper cable.

2.3 CONNECTORS

- A. Panduit (preferred), Chatsworth or Bline
- B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 1. Electroplated tinned copper, C and H shaped.
- D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- E. Busbar Connectors: Cast silicon bronze, compression connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- G. Grounding Lugs
 1. All grounding lugs shall two-hole lugs
 2. Both holes in the lugs shall be secured with appropriate hardware
 3. Attaching hardware shall be firmly secured
 4. Grounding lugs shall have a metal to metal attaching connection
 5. Painted and coated surfaces shall be neatly prepared for grounding lugs. Excessive removal of painting and/or coating shall be corrected with new product at Contractor's sole expense.
 - a. Contractor shall follow manufacturer's technical instructions for installation
 6. Outside plant cable, conduit, and terminals shall be grounded per manufacturer's instructions at all ends.

2.4 GROUNDING BUSBARS

- A. Panduit (preferred), Chatsworth or Bline
- B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.
 1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.
 1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.
 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.
- E. Telecommunications Grounding Busbar
 1. Telecommunications Main Grounding Busbar (TMGB)
 - a. The SCS Contractor shall furnish and install a TMGB in the MDF room.
 - b. Coordinate location of TMGB prior to installation with Architect.
 - c. Contractor shall ensure the TMGB are installed using only manufacturer-approved installation methods and materials.
 - d. Electrical contractor is responsible for proper grounding of TMGB to approved building ground and to the nearest panel ground.
 - e. Example Part Number: Chatsworth 40153-020
 2. Telecommunications Grounding Busbar (TGB)
 - a. The SCS Contractor shall furnish and install a TGB in each IDF.
 - b. Coordinate location of TGB prior to installation with Architect.
 - c. Contractor shall ensure the TGBs are installed using only manufacturer-approved installation methods and materials.
 - d. Electrical contractor is responsible for proper grounding of TGB to approved building ground and to the nearest panel ground.
 - e. Example Part Number: Chatsworth 13622-012
 3. Telecommunications Rack Ground Bar (RGB)
 - a. Install Rack Ground Bar Kit to each new Equipment Rack.
 - b. The SCS Contractor shall furnish and install a RGB in each new rack.
 - c. Coordinate location of RGB prior to installation with Architect.
 - d. Contractor shall ensure the RGBs are installed using only manufacturer-approved installation methods and materials.
 - e. SCS contractor is responsible for proper grounding of TGB to RGB.
 - f. Acceptable manufacturer: Chatsworth
 - g. Part Name: Rack Ground Bar Kit
 - h. Example Part Number: 40172-001

2.5 GROUND RODS

- A. Panduit (preferred), Chatsworth or Bline
- B. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet in diameter.

2.6 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

2.7 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the AC grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-B.
- D. The Contractor will be responsible for providing an approved ground at all newly installed distribution frames, and/or insuring proper bonding to all required installed equipment, devices, and support systems.

- E. The Contractor will also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
- F. All grounds will consist of an insulated #6 AWG copper wire and will be supplied from an approved building ground and bonded to the main electrical ground.
- G. Grounding must be in accordance with the NEC, NFPA and all local codes and practices.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 2/0 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 2/0 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, 2/0 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pre-twist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.
 - 1. Waveguides and Coaxial Cable:
 - a. Bond cable shields at the point of entry into the building to the TGB and to the cable entrance plate, using No. 2 AWG bonding conductors.
 - b. Bond coaxial cable surge arrester to the ground or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.7 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.8 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 FIELD QUALITY CONTROL

- A. Contractor shall perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable AC current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 27 0528

PATHWAYS FOR COMMUNICATIONS 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. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Metal wireways and auxiliary gutters.
 - 5. Nonmetallic wireways and auxiliary gutters.
 - 6. Metallic surface pathways.
 - 7. Nonmetallic surface pathways.
 - 8. Tele-power poles.
 - 9. Hooks.
 - 10. Boxes, enclosures, and cabinets.
 - 11. Polymer-concrete handholes and boxes for exterior underground cabling.
 - 12. Fiberglass handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following as applicable to project:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Tele-power poles.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Underground handholes and boxes.

- B. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.
- C. Samples: For wireways, nonmetallic wireways, surface pathways, and, tele-power poles, and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- C. Cover Sheet and Section 1 — Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- D. Section 2 — Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 - 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 - 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- E. Section 3 — Pre-Qualification Certificate
 - 1. Contractor will submit the following documents with project proposal:
 - 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 - 3. Training certificates for design, engineering and installation of the proposed products.
- F. Section 4 — Warranty Documentation
 - 1. Warranty will be for life of the installed product.
 - 2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would

be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

G. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All shown drop locations shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for the workstation faceplate.
4. Provide the MDF and IDF rack elevation details demonstrating the locations of the fiber termination shelves, copper patch panels, wire management. Show the labeling of the copper patch panel and the fiber patch panels as they will appear in the field.
5. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Conduits for this project are furnished by the Electrical Contractor under Division 26.
- B. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- C. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. IMC: Comply with ANSI C80.6 and UL 1242.
- G. PVC-Coated Steel Conduit: PVC-coated GRC or IMC as required.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- H. EMT: Comply with ANSI C80.3 and UL 797.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel or die cast per Owner standard.

- b. Type: Set screw or compression per Owner standard.
- 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Conduits for this project are furnished by the Electrical Contractor under Division 26
- B. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- C. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. RNC: Type EPC-40-PVC or Type EPC-80-PVC per Owner standard, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Rigid HDPE: Comply with UL 651A.
- F. Continuous HDPE: Comply with UL 651A.
- G. RTRC: Comply with UL 2515A and NEMA TC 14.
- H. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- I. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum, riser or general-use installation unless otherwise indicated. Installer shall verify and match conditions
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.

2.4 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

- B. Non-continuous cable supports shall be ERICO CableCat J-HOOK series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS;
- C. Adjustable non-continuous cable support sling: ERICO CADDY CableCat CAT425;
- D. Multi-tiered non-continuous cable support assemblies: ERICO CADDY CATHBA and CableCat J-Hooks with screws; or approved equal.
- E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- F. Comply with TIA-569-D.
- G. Galvanized or stainless steel.
- H. J or U shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Items listed here shall be furnished by the Electrical Contractor per Division 26.
- B. Description: Enclosures for communications.
- C. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 4. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep
 - 5. Gangable boxes are allowed.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover per Owner standards. Contractor shall verify prior to bid or installation
- F. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal per application.
 - 2. Type: Fully adjustable or Semi-adjustable per application.
 - 3. Shape: Rectangular.
 - 4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular per application.
 - 1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum, galvanized, cast iron with gasketed cover as required per application.
- J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4, Type 12 as required per application, with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures:
 - a. Material: Plastic or Fiberglass as required per application.
 - b. Finished inside with radio-frequency-resistant paint.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 1, Type 3R or Type 12 as required per application, 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.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 POLYMER-CONCRETE HANDHOLES

- A. Items listed here shall be furnished by the Electrical Contractor per Division 26
- B. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- C. General Requirements for Polymer Concrete Handholes:
 - 1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D and SCTE 77.
- D. Configuration: Designed for flush burial with open, closed or integral closed bottom per application unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 2. Cover Legend: Molded lettering, "COMMUNICATIONS".

- F. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- G. Handholes 12 Inches Wide by 24 Inches Long and Larger as required per application: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

2.8 UNSPECIFIED EQUIPMENT AND MATERIALS

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC, IMC, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC as required per application.
 - 2. Concealed Conduit, Aboveground: GRC, IMC, EMT, RNC or Type EPC-40-PVC as required per application.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC, direct buried concrete encased as required per application.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or Type 4 per application.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT or RNC as required.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT or RNC identified for such use.
 - 3. Exposed and Subject to Severe Physical Damage: GRC or IMC as required. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums
 - e. Additional designations of applicable spaces or locations.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT, RNC, Type EPC-40-PVC or innerduct as required.
 5. Damp or Wet Locations: GRC or IMC as required.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT as required for application.
 7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, Riser-type, communications-cable pathway EMT as required for application
 8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, General-use, communications-cable pathway, Riser-type, communications-cable pathway, Plenum-type, communications-cable pathway, EMT as required for application.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel or nonmetallic units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use set-screw or compression, steel or cast-metal fittings as required for application. Comply with NEMA FB 2.10.
 4. Conduit runs installed by the contractor should not exceed 100 feet or contain more than two 90-degree bends without utilizing appropriately sized pull boxes.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.

- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Pathways 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. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 1 to 2 inches depending on application of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from nonmetallic conduit and fittings to RNC, Type EPC-40-PVC, GRC or IMC and fittings as required per application before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- U. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
 - 4. Conduit runs installed by the contractor should not exceed 100 feet or contain more than two 90-degree bends without utilizing appropriately sized pull boxes.
- W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- X. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - e. Contractor shall note applicable temperature changes based on environment prior to bidding or installation.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. No support may be secured to the drop ceiling grid support wire. Contractors installing their support devices to the grid wire will replace the assembly at no cost to the Owner, the Architect or the General Contractor.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 48 to 60 inches on center.
5. Provide a hook at each change in direction.
6. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
7. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
8. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
9. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
10. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL Listed.

11. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
 12. In suspended ceiling and raised floor areas where walker duct, cable trays or conduit are not available, the Contractor will bundle station wiring with hook-and-loop (Velcro) cable straps at appropriate distances.
 13. Each J-hook shall contain only one type of transmission media.
 14. Cables shall not be support by ductwork.
 15. Cables shall not wrap around building structural systems.
 16. Every effort will be made to schedule the requirements under this Contract in such a manner so as to complete all above ceiling work prior to ceiling tile installation. In the event Contractor is required to remove ceiling tiles, such Work will not break or disturb grid and must be coordinated with the General Contractor.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center, top, or bottom of box as required by application. Contractor shall verify with Owner or Consultant prior to bid or installation.
- CC. 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. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set metal floor boxes level and flush with finished floor surface.
- HH. 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 Section 312000 "Earth Moving" for pipe of less than 6 inches in nominal diameter.
 2. Install backfill as specified in Section 312000 "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 Section 312000 "Earth Moving."
 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

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 with bottom below frost line, this depth varies depending on zone. Contractor shall coordinate depth prior to bid or installation.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 0529

HANGERS AND SUPPORTS FOR COMMUNICATIONS 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. Steel slotted support systems for communication raceways.
 - 2. Aluminum slotted support systems for communication raceways.
 - 3. Nonmetallic slotted support systems for communication raceways.
 - 4. Conduit and cable support devices.
 - 5. Support for conductors in vertical conduit.
 - 6. Structural steel for fabricated supports and restraints.
 - 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 8. Fabricated metal equipment support assemblies.
- B. Related Requirements:
 - 1. Section 270548 "Seismic Controls for Communications Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following as required for this project:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.
 - 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Aluminum slotted-channel systems.
 - 4. Nonmetallic slotted-channel systems.
 - 5. Equipment supports.
 - 6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for communications systems.
 - 1. Include design calculations and details of trapeze hangers.
 - 2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Ductwork, piping, fittings, and supports.
 - 3. Structural members to which hangers and supports will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- C. Cover Sheet and Section 1 — Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- D. Section 2 — Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.

2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.

E. Section 3 – Pre-Qualification Certificate

1. Contractor will submit the following documents with project proposal:
2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
3. Training certificates for design, engineering and installation of the proposed products.

F. Section 4 – Warranty Documentation

1. Warranty will be for life of the installed product.
2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

G. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All shown drop locations shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for the workstation faceplate.
4. Provide the MDF and IDF rack elevation details demonstrating the locations of the fiber termination shelves, copper patch panels, wire management. Show the labeling of the copper patch panel and the fiber patch panels as they will appear in the field.
5. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

H. Welding certificates as required for this project.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 as required by zone.
 - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Not currently required for this project
 - 2. Acceptable Manufacturers:
 - 3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 4. Material for Channel, Fittings, and Accessories: Galvanized steel, Plain steel, Stainless Steel, Type 304, Stainless Steel, Type 316.
 - 5. Channel Width: 1-5/8 inches, 1-1/4 inches, 13/16 inches.
 - 6. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 7. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 8. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 9. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 10. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Not currently required for this project
 - 2. Acceptable Manufacturers:
 - 3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 4. Channel Material: 6063-T6 aluminum alloy.
 - 5. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 6. Channel Width: 1-5/8 inches, 1-1/4 inches, 13/16 inches.
 - 7. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

8. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 9. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 10. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Not currently required for this project
 2. Acceptable Manufacturers:
 3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 4. Channel Width: 1-5/8 inches, 1-1/4 inches, 13/16 inches.
 5. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 6. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 7. Rated Strength: Selected to suit applicable load criteria.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel, Stainless-steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications 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 made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. 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. Acceptable Manufacturers:
 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, stainless steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Acceptable Manufacturers:
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are 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, Stainless-steel springhead type.

7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

2.4 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. 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 two-bolt conduit clamps, using spring friction action for retention in support channel.

- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- B. 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.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications 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: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps].
 - 7. To Light Steel: Sheet metal screws.
 - 8. 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 by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "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 communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 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.
- B. Touchup: Comply with requirements 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

SECTION 27 0536

CABLE TRAYS FOR COMMUNICATIONS 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. Ladder cable tray.
 - 2. Wire-mesh cable tray.
 - 3. Single-rail cable tray.
 - 4. Trough cable tray.
 - 5. Fiberglass cable tray.
 - 6. Cable tray accessories.
 - 7. Warning signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. 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 sides 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 2. Vertical and horizontal offsets and transitions.
 3. Clearances for access above and to side of cable trays.
 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- C. Cover Sheet and Section 1 – Information, Pricing and Material
1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 3. Description of work narrative in Word format detailing what is included in your proposal.
- D. Section 2 – Product Data
1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- E. Section 4 – Warranty Documentation
1. Warranty will be for life of the installed product.
 2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
- F. Section 5 – Record Drawings
1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
 2. Provide an example of the required pathway labeling.
 3. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.5.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 deg F, material surfaces

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

- A. Acceptable Manufacturer: Chatsworth
 - 1. Part Number: 10250-712
 - 2. Part Number: 10250-718
- B. Description:
 - 1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 - 2. Width: 12 inches or 18 inches unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: 3 inches.

4. Straight Section Lengths: except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 12 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Class Designation: Comply with NEMA VE 1, Class 5A
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Covers: Solid, Louvered or Ventilated-hat with 2-in-3 pitch type made of same materials and with same finishes as cable tray as required by Owner standard.

C. Materials and Finishes:

1. Steel:
 - a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
 - 1) Hardware: Chromium-zinc plated, ASTM F 1136
 - e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A 653/A 653M, G90.
 - 1) Hardware: Chromium-zinc plated, ASTM F 1136.
 - f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
 - 1) Hardware: Galvanized, ASTM B 633.
 - g. Finish: Powder-coat enamel paint.
 - 1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - 2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
 - 3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
 - 4) Hardware: Chromium-zinc plated, ASTM F 1136.
 - h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
 - i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.
2. Aluminum:

- a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
 - b. Hardware: Chromium-zinc-plated steel, ASTM F 1136
 - c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
3. Stainless Steel:
- a. Materials: Low-carbon, passivated stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
 - b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 WIRE-MESH CABLE TRAY

- A. Acceptable manufacturer and product is Cablofil CF54/300 Wire Cable Tray.
- B. Description:
- 1. Configuration: Galvanized steel wire mesh, complying with NEMA VE 1.
 - 2. Width: 12 inches unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: 2 inches.
 - 4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 - 5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
 - 6. Class Designation: Comply with NEMA VE 1, Class 5A.
 - 7. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
- C. Materials and Finishes:
- 1. Steel:
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
 - 1) Hardware: Galvanized, ASTM B 633, Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316 as required per application.
 - e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A 653/A 653M, G90.
 - 1) Hardware: Galvanized, ASTM B 633, or Chromium-zinc plated, ASTM F 1136.

- f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
 - 1) Hardware: Galvanized, ASTM B 633.
- g. Finish: Epoxy-resin or Powder-coat enamel paint.
 - 1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - 2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
 - 3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
 - 4) Hardware: Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
- h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
- i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
 - 1. E-bend Part Number: 10822-712
 - 2. Provide and install 18" rack stand-offs for the 12" ladder rack
 - 3. Butt Splice Kit Part Number: 11301-701
 - 4. Junction Splice Kit Part Number: 11302-701
 - 5. 90 Degree Runway Splice Kit Part Number: 11314-701
 - 6. 45 Degree Runway Splice Kit Part Number: 11313-701
 - 7. Cable Runway Elevation Kit Part Number, 2", 2.5", 3": 10506-702
 - 8. Channel to Rack Mounting Plate Part Number: 10595-712 or -718
 - 9. Triangular Support Bracket, Steel Part Number: 11312-712 or -718
 - 10. Wall Angle Support Kit, Cable Runway Part Number: 11421-712 or -718
 - 11. J-Bolt Kit, Cable Runway Part Number: 11308-701
 - 12. Cable Retaining Post 6" Height Part Number: 10596-706
 - 13. Protective End Caps for Runway Part Number: 10642-001
 - 14. Touch-Up Paint in Spray Can Part Number: 25400-700
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

- A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1.

2.8 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA FG 1.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints as required per zone.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems." "Comply with seismic-restraint details according to Section 270548.16 "Seismic Controls for Communications Systems."
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA FG 1. Do not install more than one cable tray splice between supports.

- M. Support trapeze hangers for wire-basket trays with 3/8-inch diameter rods.
- N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- P. Make changes in direction and elevation using manufacturer's recommended fittings.
- Q. Make cable tray connections using manufacturer's recommended fittings.
- R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- S. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- T. Install cable trays with enough workspace to permit access for installing cables.
- U. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.
 - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
 - 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 0544

SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 – Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 – Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 - 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 - 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.

D. Section 3 – Pre-Qualification Certificate

1. Contractor will submit the following documents with project proposal:
2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
3. Training certificates for design, engineering and installation of the proposed products.

E. Section 4 – Warranty Documentation

1. Warranty will be for life of the installed product.
2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

F. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All sleeve locations shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for sleeves.
4. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

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

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

- a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
- b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 1. Acceptable Manufacturer: Hilti, Wiremold or approved equivalent
 2. Approved Products: Flamestopper Thru-Wall Fitting for Fire Walls or equal.
 3. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 4. Pressure Plates: Carbon steel, Plastic or Stainless steel as required per application.
 5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements as required per application.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Approved Manufacturer: Hilti or approved equivalent

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Approved Manufacturer: Hilti or approved equivalent
- C. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

2.6 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 3 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- C. Cable tray penetration through fire rated construction must be filled after cable is installed to maintain fire rating of original construction as shown on architectural drawings.
 - 1. Intumescent sealants, fire blocks, caulking, and all other firestopping materials shall meet the UL standards and local code(s).
- D. Where a cable or bundle of cables exits a cable tray and penetrates a fire rated construction a conduit shall be provided to pass through that construction. Conduit must be sized for 250% of installed capacity.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 27 0553

IDENTIFICATION FOR COMMUNICATIONS 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. Color and legend requirements for labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Tapes.
 - 5. Signs.
 - 6. Cable ties.
 - 7. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule:
 - 1. Outlets: Scaled drawings indicating location and proposed designation.
 - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
 - 3. Racks: Scaled drawings indicating location and proposed designation.
 - 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-C.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field for faceplates, ceiling grids.
 - 2. White letters on a black field for patch panels and rack.
 - 3. Contractor shall label all; racks, cabinets, faceplates, fiber shelves, cables, grounding components.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Approved Manufacturers: Panduit, Brady or Owner approved equal.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
 - 1. Approved Manufacturers: Panduit, Brady or Owner approved equal.
- C. Self-Adhesive Wraparound Labels: Preprinted or Write-on, 3-mil-thick, polyester or vinyl flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Approved Manufacturer: Panduit, Brady or Owner approved equal.
 - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 3. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.

4. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 1. Approved Manufacturers: Panduit, Brady or Owner approved equal
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
 1. Approved Manufacture: Panduit, Brady or Owner approved equal

2.5 UNDERGROUND-LINE WARNING TAPE

- A. Approved Manufacturer: Brady, Greenlee or Owner approved equal
- B. Tape:
 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications 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 degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- C. Color and Printing:
 1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
 2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE" as required for application. Contractor shall match the product for the application.
- D. Tag: Type I:
 1. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 2. Width: 3 inches.
 3. Thickness: 4 mils.

4. Weight: 18.5 lb/1000 sq. ft..
 5. Tensile according to ASTM D 882: 30 lbf and 2500 psi.
- E. Tag: Type II :
1. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 2. Width: 3 inches.
 3. Thickness: 12 mils.
 4. Weight: 36.1 lb/1000 sq. ft..
 5. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.
- F. Tag: Type ID:
1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 2. Width: 3 inches.
 3. Overall Thickness: 5 mils.
 4. Foil Core Thickness: 0.35 mil.
 5. Weight: 28 lb/1000 sq. ft..
 6. Tensile according to ASTM D 882: 70 lbf and 4600 psi.
- G. Tag: Type IID:
1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 2. Width: 3 inches.
 3. Overall Thickness: 8 mils.
 4. Foil Core Thickness: 0.35 mil.
 5. Weight: 34 lb/1000 sq. ft..
 6. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

2.6 SIGNS

A. Baked-Enamel Signs:

1. Not currently required for this project
2. Approved Manufacturer:
3. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
4. 1/4-inch grommets in corners for mounting.
5. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Approved manufacturer:
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:

1. Approved Manufacturer:
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with white letters on a dark gray background.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting, Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Cable ties are not allowed on-site.

1. The Architect's experience is that Category 6 cable is irrevocably harmed with the use of cable ties.
2. Cables bundled with tie wraps during any phase of the installation will be removed and replaced with new product at the Contractor's expense.
3. Contractor must receive written authorization from Architect to use tie wraps for any purpose.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- I. Snap-Around Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.

2. Provide label 6 inches from cable end.
- J. Self-Adhesive Wraparound Labels:
 1. Secure tight to surface at a location with high visibility and accessibility.
 2. Provide label 6 inches from cable end.
- K. Self-Adhesive Labels:
 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- M. Underground-Line Warning Tape:
 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 2. Limit use of underground-line warning tape to direct-buried cables.
 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- N. Cable Ties: General purpose, except as listed below:
 1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 1. System legends shall be as follows:
 - a. Telecommunications.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:

1. Wiring closet designation.
 2. Colon.
 3. Faceplate number.
- E. Equipment Room Labeling:
1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 2. Patch Panels: [Label individual rows in each rack, starting at top and working down, with self-adhesive labels.] [Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.]
 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- F. Backbone Cables: Label each cable with a vinyl-wraparound label, snap-around label or self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- G. Horizontal Cables: Label each cable with a vinyl-wraparound label or self-adhesive wraparound label indicating the following, in the order listed:
1. Room number.
 2. Colon.
 3. Faceplate number.
- H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- I. Instructional Signs: Self-adhesive labels.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels, Baked-enamel warning signs or Metal-backed, butyrate warning signs.
1. Apply to exterior of door, cover, or other access.
- K. Equipment Identification Labels:
1. Indoor Equipment: [Self-adhesive label] [Baked-enamel signs] [Metal-backed butyrate signs] [Laminated-acrylic or melamine-plastic sign].
 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign or Stenciled legend 4 inches high.
 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.

- c. Computer room air conditioners.
- d. Fire-alarm and suppression equipment.
- e. Egress points.
- f. Power distribution components.

END OF SECTION

SECTION 27 1100

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards.
 - 2. Boxes, enclosures, and cabinets.
 - 3. Power strips.
- B. Related Requirements:
 - 1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
 - 2. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
 - 3. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 4. Section 271333 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
 - 5. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
 - 6. Section 271523 "Communications Optical Fiber Horizontal Cabling" for coaxial data cabling associated with system panels and devices.
 - 7. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. TGB: Telecommunications grounding bus bar.

- F. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 – Information, Pricing and Material
1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 – Product Data
1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- D. Section 3 – Pre-Qualification Certificate
1. Contractor will submit the following documents with project proposal:
 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 3. Training certificates for design, engineering and installation of the proposed products.

E. Section 4 – Warranty Documentation

1. Warranty will be for life of the installed product.
2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

F. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All equipment shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for each item.
4. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of an RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Level 2 Technician, Copper or Fiber, 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 an RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: As required, equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, Telcordia GR-63-CORE requirements for local Zone Seismic Earthquake Environments.

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

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

1. Plywood shall be Paint-Grade Birch
2. Plywood shall be painted white

- 3. Finish side shall be on surface
- B. Plywood shall meet all applicable codes

2.3 Ladder Rack

- A. Acceptable Manufacturer: Chatsworth
- B. Ladder Rack Part Number: 10250-712
- C. E-Bend Part Number 10822-712
- D. Contractor will install 12" ladder rack in the MDF/IDF as shown in T series drawings.
 - 1. Scope includes 12" ladder rack to AT&T Gigaman rack location.
- E. Ladder rack will be black in color.
- F. Provide and install 18" rack stand-offs for the 12" ladder rack
- G. Contractor will ground all ladder rack in the MDF/IDF
- H. Contractor will secure the ladder rack to the top of the equipment rack with the proper mounting plate.
- I. Contractor will install protective boots at each end of the rack assembly.
- J. Contractor will be responsible for providing the required amount of support equipment including but not limited to wall angle brackets, triangle support brackets, butt splice kits, junction splice kits, cable runway E-bends, rack to runway mounting plates etc.

2.4 POWER STRIPS

- A. These are currently Owner furnished and Owner installed.
- B. Comply with requirements in Section 271116 "Communications Racks, Frames, and Enclosures."
- C. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting

2.5 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 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. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground, buried or aerial pathways as required for this project.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- 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.
- E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 - 4. Adjust configurations 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 equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:
 - 1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 - 2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
 - 3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION

SECTION 27 1116

COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

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. 19-inch free-standing equipment racks.
2. 19-inch wall-mounted equipment cabinets.
3. Four-post equipment racks.
4. Power strips.
5. Grounding.
6. Labeling.

- B. Related Requirements:

1. Section 271110 "Communications Equipment Room Fittings" for backboards and accessories.
2. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
3. Section 270536 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.
4. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
5. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
6. Section 271333 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
7. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
8. Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical-fiber data cabling associated with system panels and devices.
9. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.
10. Section 271611 "Communications Hybrid Cabling" for combined copper and optical fiber data cables associated with system panels and devices.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TGB: Telecommunications grounding bus bar.
- G. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.
- B. Shop Drawings: For communications racks, frames, and enclosures. 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 TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 — Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 — Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.

2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.

D. Section 3 – Pre-Qualification Certificate

1. Contractor will submit the following documents with project proposal:
2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
3. Training certificates for design, engineering and installation of the proposed products.

E. Section 4 – Warranty Documentation

1. Warranty will be for life of the installed product.
2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

F. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All shown drop locations shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for the workstation faceplate.
4. Provide the MDF and IDF rack elevation details demonstrating the locations of the fiber termination shelves, copper patch panels, wire management. Show the labeling of the copper patch panel and the fiber patch panels as they will appear in the field.
5. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD, Technician.
2. Installation Supervision: Installation shall be under direct supervision of Technician Installer 2, Copper or Fiber, 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 an RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: As required, equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, Telcordia GR-63-CORE requirements for local zone Seismic Earthquake Environments.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. UL listed.
- C. RoHS compliant.
- D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."
 - 1. Plywood shall be Paint-Grade Birch
 - 2. Plywood shall be painted white
 - 3. Finish side shall be on surface
- B. Plywood shall meet all applicable codes

2.3 19-INCH EQUIPMENT RACKS

- A. Description: Two-post and four-post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. MDF/IDF Frame
 - 1. Acceptable manufacturer: Chatsworth
 - 2. Part Name: QuadraRack 4-Post Frame with Vertical Wire Management
 - 3. Part #: 50120-703
 - 4. Contractor will provide and install black Chatsworth 4-Post Frame Racks in location and quantity per T Series drawings.
- C. MDF/IDF Equipment Rack
 - 1. Acceptable manufacturer: Chatsworth
 - 2. Part Name: 7' Standard Rack with Vertical Wire Management
 - 3. Part # 55054-703 with Vertical Wire Management 30095-703
 - 4. Contractor will provide and install Equipment Racks in location and quantity per T Series drawings.
- D. General Requirements:

1. The equipment racks will be made of high strength 6061-T6 aluminum construction, black in color and include all required mounting hardware and vertical wire management on both sides of the rack.
2. Vertical wire management will offer double-sided management and be 6" wide.
3. Vertical wire management will have a removable door to cover the cables when access is not required.
4. Racks will be mounted on an isolation pad and utilize non-conductive washers to secure the rack to the floor.
5. Floor mounted open racks will be secured from the top rail to the backboard in the room with a length of cable runway to prevent movement.
6. All racks will be grounded to the isolated ground bar within the MDF/IDF using a standard ground lug and #6 jacketed green cable.

2.4 19-INCH EQUIPMENT CABINETS

A. Modular Wall Cabinets:

1. Height: 22 inches As indicated on Drawings
2. Depth: 23 inches
3. Load Rating: 150 lb
4. Number of Rack Units: 12 As indicated on Drawings
5. Threads: 12-24.
6. Lockable front doors.
7. Louvered side panels.
8. Cable access provisions top and bottom.
9. Grounding lug.
10. Roof-mounted, 250-cfm fan.
11. Power strip.
12. All cabinets keyed alike.

B. Cable Management:

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 top of each relay rack, with a minimum height of two rack units each.

2.5 EQUIPMENT RACK ACCESSORIES

A. Provide and install keyboard trays and monitor trays in locations and quantity shown on T Series drawings. Contractor to provide all necessary mounting hardware.

B. Acceptable Manufacturer: Chatsworth

1. Keyboard Tray Part #: 12193-701
2. Monitor Tray Part #: 11245-719

C. General Requirements:

1. Provide one set per MDF and on set in each IDF. Coordinate mounting height with Owner prior to installation.

2.6 POWER STRIPS

- A. These are currently Owner furnished and Owner installed.
- B. Comply with requirements in Section 27 1100 "Communications Equipment Room Fittings"
- C. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting.

2.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-C. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
 - 2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.8 LABELING

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.9 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

- 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.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations 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 equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with the latest version of NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.
- C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.
 - 1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-C. Comply with requirements in Section 270553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration, including optional identification requirements of this standard.
- D. Labels shall be machine printed. Type shall be 1/4 inch in height.

END OF SECTION

SECTION 27 1313

COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable
 - 2. Twisted pair cable hardware, including plugs, jacks, patch panels, and cross-connects.
 - 3. Grounding provisions for twisted pair cable.
 - 4. Cabling identification.
 - 5. Source quality control requirements for twisted pair cable.
- B. Related Requirements:
 - 1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. F/FTP: Overall foil screened cable with foil screened twisted pair.
- D. FTP: Shielded twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- H. LAN: Local area network.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.

- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. S/FTP: Overall braid screened cable with foil screened twisted pair.
- M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER BACKBONE CABLING DESCRIPTION

- A. Copper 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 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. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
 - 5. Cross-Connects and Patch Panels: Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written

documentation from the Architect or General Contractor. The combined file will be organized into the following sections:

- B. Cover Sheet and Section 1 – Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 – Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 - 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 - 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- D. Section 3 – Pre-Qualification Certificate
 - 1. Contractor will submit the following documents with project proposal:
 - 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 - 3. Training certificates for design, engineering and installation of the proposed products.
- E. Section 4 – Warranty Documentation
 - 1. Warranty will be for life of the installed product.
 - 2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
- F. Section 5 – Record Drawings
 - 1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
 - 2. All backbones shall be labeled in accordance with the specifications.
 - 3. Provide an example of the required labeling for the backbone cabling.
 - 4. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development 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: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. 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.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing 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.
- C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Furnish two (2) 4-pair Category 6 UTP cable from the MDF to each IDF.
- C. Acceptable Manufacturer: CommScope
 - 1. Uniprise Media 6 Solution, Part Number 6504
- D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables
- E. Conductors: 100-ohm, 23 AWG solid copper.
- F. Shielding/Screening: Unshielded balanced twisted pairs (UTP).
- G. Cable Rating: Plenum.
- H. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Acceptable Manufacturer: CommScope Uniprise
- C. General Requirements for Cable Connecting Hardware:
 - 1. Twisted pair cable hardware shall meet the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
 - 4. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

- D. Connecting Blocks: Wall mounted 110-style IDC for Category 6 Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One, 1 for each conductor in assigned cables.
- F. Legend:
 - 1. Factory labeled by silk-screening or engraving for stainless steel, brass, faceplates.
 - 2. Machine printed, in the field, using adhesive-tape label.
 - 3. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLING IDENTIFICATION

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-C.

2.7 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

2.8 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications 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. Install cables parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- D. Comply with Section 270536 "Cable Trays for Communications Systems."
- E. Drawings indicate general arrangement of pathways and fittings.

3.4 INSTALLATION OF COPPER BACKBONE CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
9. 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.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 48 to 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper 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.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
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.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, 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.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.6 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-C and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications 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. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration, including optional identification requirements of this standard.
- C. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling" for cable and asset management software.

- D. 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.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches 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 the device if wire color 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. 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, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - 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.
- G. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections shall be performed by the Installer.
- E. Tests and Inspections:
 - 1. Visually inspect 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-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test 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-568-C.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.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.
- J. Should the performance testing show that the installer has not properly completed the systems, the installer shall make all necessary corrections or adjustments and a second demonstration shall be arranged at the installer's expense. Should the Consultant be required to return due to incomplete systems, the installer shall be responsible for the Consultant's fee at \$800 per return visit.

END OF SECTION

SECTION 27 1323

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
 - 2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
 - 3. Cabling identification products.

1.3 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. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 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. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
 5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Optical fiber cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 — Information, Pricing and Material
1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 — Product Data
1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- D. Section 3 — Pre-Qualification Certificate
1. Contractor will submit the following documents with project proposal:
 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 3. Training certificates for design, engineering and installation of the proposed products.
- E. Section 4 — Warranty Documentation
1. Warranty will be for life of the installed product.
 2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would

be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

F. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All backbone locations shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for the backbone.
4. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Patch-Panel Units: One, 1 of each type.
 2. Plugs: Ten, 10 of each type.
 3. Jacks: Ten, 10 of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development 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: Testing agency must have personnel certified by BICSI on staff.
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.10 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 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.

1.11 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.

1.12 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.13 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two, 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, 2 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 Thirty, 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. 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.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.2 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

- A. Description: Multimode, 50/125-micrometer, 12-fiber, interlocking-armored tight buffer, optical fiber cable.
- B. Acceptable Manufacturer:
 - 1. CommScope, Systimax
- C. Standards:
 - 1. Comply with ICEA S-83-596 for mechanical properties.
 - 2. Comply with TIA-568-C.3 for performance specifications.
 - 3. Comply with TIA-492AAAD for detailed specifications.
- D. Conductive cable shall be aluminum armored type.
- E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
- F. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- G. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.
- H. Jacket:
 - 1. Jacket Color: Aqua.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- I. 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:
 - 1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 2. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
 - 3. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.

2.3 OPTICAL FIBER CABLE HARDWARE

- A. Acceptable Manufacturer: CommScope Uniprise
 - 1. MDF Part #: CommScope Fiber Enclosure RFE-FXD-EMT-BK/4U
 - 2. IDF Part #: CommScope Rack Mounted Sliding Termination and Splice Shelf RFE-SLG-EMT/1U
- B. Contractor shall provide all applicable parts for fiber termination enclosures provisioning for terminating strands. These parts may include, but are not limited to, connectors, adapter panels, bulkheads, termination kits, and consumables.
- C. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
 2. Comply with TIA-568-C.3.
- D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One, 1 for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- E. Patch Cords: Factory-made, dual-fiber cables in 2-meter lengths.
1. Acceptable Manufacturer: CommScope Uniprise
 2. Part Number: RFJ-02SP29-5L-SCU-02-SCU
- F. Connector Type: Type SC complying with TIA-604-3-B, connectors.
1. Patch cords will be 50/125 μm .
- G. Plugs and Plug Assemblies:
1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
 2. Insertion loss not more than 0.25 dB.
 3. Marked to indicate transmission performance.
- H. Jacks and Jack Assemblies:
1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
 2. Insertion loss not more than 0.25 dB.
 3. Marked to indicate transmission performance.
 4. Designed to snap-in to a patch panel or faceplate.

2.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-C.

2.5 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Installer shall be responsible for performance testing.
- B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

- C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

2.7 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications 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.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568-C.1 and TIA-568-C.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables shall be continuous and may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 7. 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.
 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable and neatly store and secure above the ceiling.
 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
 12. Cable may not exceed allowable bend radius according to manufacturer, BICSI and ANSI/TIA standards.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

- A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-C and NECA/BICSI-607.
- 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.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 2
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.
- C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- D. 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.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches 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. 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.
- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
 - 1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Visually inspect 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-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.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 one direction according to TIA-526-14-B, 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 those calculated according to equation in TIA-568-C.1.
- F. 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.
- G. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.
- J. Should the performance testing show that the installer has not properly completed the systems, the installer shall make all necessary corrections or adjustments and a second demonstration shall be arranged at the installer's expense. Should the Consultant be required to return due to incomplete systems, the installer shall be responsible for the Consultant's fee at \$800 per return visit.

END OF SECTION

SECTION 27 1513

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Category 6a twisted pair cable.
 - 3. Twisted pair cable hardware, including plugs and jacks.
 - 4. Cabling identification products.
 - 5. Grounding provisions for twisted pair cable.
 - 6. Source quality control requirements for twisted pair cable.
- B. Related Requirements:
 - 1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.
- C. The Data Cabling Contractor shall include a provision for (10) ten additional Category 6 data drops to be placed by the Owner as needed. These drops may be utilized ONLY through the Owners Technology Director's approval.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

- A. Bidding Contractor is invited to submit bids for the structured cable solution if Contractor meets the certification and other requirements detailed below.
- B. The Bidder will be required to provide the following documents with the bid response:
 - 1. Proof of certification from the Manufacturer. For this project the bidder must be certified by CommScope. Bidders on probation with this program may not be selected.
 - 2. Bidder must be able to provide a system certification covering link/channel specifications from the manufacturing company for the lifetime of the products they are installing.
 - 3. Bidder shall provide a sample of the warranty that is applicable to the project when complete and documentation of the support procedure for warranty issues.
- C. Product Data: For each type of product.
- D. Shop Drawings: Reviewed and stamped by RCDD.

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 and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.
- E. Twisted pair cable testing plan.
- F. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration, and faceplates for color selection and evaluation of technical features.

1.6 INFORMATIONAL SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 – Information, Pricing and Material
1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 – Product Data
1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- D. Section 3 – Pre-Qualification Certificate
1. Contractor will submit the following documents with project proposal:
 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 3. Training certificates for design, engineering and installation of the proposed products.
- E. Section 4 – Warranty Documentation

1. Warranty will be for life of the installed product.
2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.

F. Section 5 – Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All shown drop locations shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for the workstation faceplate.
4. Provide the MDF and IDF rack elevation details demonstrating the locations of the fiber termination shelves, copper patch panels, wire management. Show the labeling of the copper patch panel and the fiber patch panels as they will appear in the field.
5. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: provide as-built drawing sets in electronic format on USB media. As-built drawings shall show:
1. Outlet location and numbering
 2. Cable pathway and routing
 3. Contractor logo, name, address, telephone number, and date completed
- B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On USB media, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faceplates: One, 1 of each type.
 2. Jacks: Ten, 10 of each type.
 3. Patch-Panel Units: One, 1 of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Technician 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: Testing agency must have personnel certified by BICSI on staff.
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
1. Test each pair of twisted pair cable for open and short circuits.

1.11 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.

1.12 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.13 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two, 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, 2 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 Thirty, 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-C.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.
 - 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
 - 3. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.
 - 4. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
 - 5. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing 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.
- C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Subject to compliance with requirements, provide products by the following:
 - 1. CommScope Uniprise Media 6 Solution
 - a. Part Number: 6504
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP)
- F. Cable Rating: Plenum
- G. Jacket: Blue thermoplastic.

2.4 CATEGORY 6A TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.
- B. For all AP locations, install the following cable:
 - 1. CommScope Uniprise Ultra 10
 - 2. Part Number: 10GS4
- C. Standard: Comply with TIA-568-C.2 for Category 6A cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP), Screened twisted pairs (F/UTP)
- F. Cable Rating: Plenum.
- G. Jacket: Blue thermoplastic.

2.5 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6 or Category 6A.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer. Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- D. Connecting Blocks:
 - 1. 110-style IDC for Category 6.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. 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.
- F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Acceptable Manufacturer:
 - a. CommScope Uniprise Angled 48 Port, Category 6 (PN: UNP610-ANG-48P)
 - b. CommScope Uniprise FTP-MOD-24P Category 6A for all AP locations terminating in the MDF/IDF.

2. Contractor will calculate the number of ports based on the number of LAN outlets served by the IDF or MDF. All voice and data station cables will terminate on the same patch panel. Patch panel density must provide for an additional 10% growth capability.
 3. Provide and install rear patch panel cable support system
 4. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
 5. Patch panel will provide labeling for all ports on the patch panel and will have a port identification that is visible with cords in place.
- G. Patch Cords: Factory-made, four-pair cables in various lengths; terminated with an eight-position modular plug at each end. Cords may not be lengthened, shortened, spliced, or field terminated by Contractor.
1. Acceptable Manufacturer: CommScope
 - a. Part Number: UNC6, Category 6 blue in color
 - b. Part Number: FTP-PC6A-XXX Category 6A for all AP locations
 2. Patch cords shall be of the same, or better, cable type as the installed horizontal cable.
 3. Patch cords shall be provided by the Contractor at each terminated point in a building.
 - a. Work Area patch cords shall be 7ft in length
 - b. Provide only 1ft patch cords for MDF/IDF's.
 - c. For all AP locations, provide a 1ft cord in the MDF/IDF's and a 7ft cord at the device.
 4. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 5. Patch cord delivery shall be done using the General Contractor's transmittal process.
- H. Category 6 Outlets:
1. Acceptable Manufacturer(s) and Part Number:
 - a. CommScope UNJ600-BL Category 6
 - b. CommScope FTP-J6A
 - c. Category 6 Outlets shall be Blue in color
 2. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 3. Designed to snap-in to a patch panel or faceplate.
 4. Standard: Comply with TIA-568-C.2.
 5. Marked to indicate transmission performance.
- I. Faceplate:
1. Acceptable Manufacturer:
 - a. CommScope Modular Flush-Mount Faceplate
 - b. Part Numbers: UNF-MFM-4P-WH
 2. Work area outlets will consist of a single gang 4-port faceplate in a single gang configuration.
 3. All unused ports will be filled in with a blank module. The blank module will match the faceplate for color.
 - a. Acceptable manufacturer: CommScope
 - b. Part Number: UNDC-WH
 4. Plastic Faceplate: High-impact plastic. Faceplate color will be coordinated with the Architect prior to purchase and installation.
 5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

J. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-C.

2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test twisted pair cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

2.9 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional SCS installation will be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications 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. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- D. Comply with Section 270536 "Cable Trays for Communications Systems."
- E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. MUTOA shall not be used as a cross-connect point.
 - 7. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
 - 8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information

- Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. 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.
 12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 13. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
 14. Service loops will be installed at the work area outlet above the conduit stub-up in a J-hook. Loop will be 36" of cable and configured in an industry standards compliant arrangement.
 15. Category 6 UTP cables will extend between the station location and its associated MDF/IDF and consists of 4 pair, 24 gauge, UTP, and will terminate on 8 pin modular jacks provided at each outlet. The contractor is responsible for knowing which outlets terminate at the proper IDF or MDF. Refer to the T-series Sheets for outlet locations terminating in the MDF/IDF.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 48 to 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper 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.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 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.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways, 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.

- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-C and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 2.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 2 level of administration, including optional identification requirements of this standard.
- C. 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.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches 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 the device if wire color 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. 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, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - 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.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent to the following systems:
 - a. Spaces
 - b. Pathways
 - c. Cable
 - d. Termination Hardware
 - e. Termination Position
 - f. Grounding & Bonding System
2. Format of cable, faceplate insert, and patch panel port label will be the same
3. The MDF identifier is "MDF"
4. Each IDF will have a unique alpha character (e.g. IDF "A")
5. Numeric identifier will be determined by patch panel port position
 - a. Cable terminated to upper left port on first patch panel will be 001
 - b. Cable terminated to upper left port on second patch panel will be 049 (presupposing the first patch panel is a 48-port patch panel)
6. Examples:
 - a. MDF 001
 - b. IDF A 001

G. Labeling — Station Cable

1. The Contractor will be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, according to Mansfield ISD approved specifications at the time of delivery.
 - a. The Contractor will label, according to MISD cabling standards, all cable runs at the MDF/IDF and Station Cable locations.
 - b. MISD labeling standard requires the following information to be visible at each work area insert:
 - 1) MDF/IDF #
 - 2) Patch Panel Port #
 - c. Examples:

- 1) Cable from an IDF would be similar to: IDF B 007 where "B" indicates IDF identifier, and "007" indicates Patch Panel port #
 - 2) Cable from the MDF would be similar to: MDF 007 where "MDF" indicates MDF, and "007" indicates Patch Panel port #
- d. d. d. The Contractor shall label both ends of each cable within four (4) inches of the termination.
 - e. e. Labels shall be machine printed Brady (or equivalent).
 - f. Labels will not be written by hand.

H. Labeling — Face Plates

1. The Contractor will label wall outlet covers on top or front with the cable drop identifier described above.
2. Affix a machine printed Brady (or equivalent) on the faceplate to identify the insert channel.
3. Access Points and Cameras shall be labeled as to identify their purpose.
 - a. Access Point labeling shall add "AP" in the labeling and outlets in the plenum space shall have an additional label on the ceiling grid runners viewable from the finished floor side.
 - b. Cameras shall have "CAM" in the labeling
 - c. Labels shall be white with black letters. Font size will be standardized at all locations.
 - d. Contractor to verify this nomenclature with the District, as well as the District room numbers, prior to labeling.

I. Labeling — Patch Panels

1. Patch panel ports will be labeled using numeric identifier 01-48.
2. The patch panel port on the upper left will be port 1. Sequence will be from left to right, then next row resume the number sequence (typically 25-48).
3. Patch panel port labeling shall be machine generated (Brady or equivalent).
4. Labels will not be written by hand.

J. Labeling — Ceiling tiles

1. Contractor will place a machine generated label on the ceiling grid directly below the location of the data drop termination. Labels will match the faceplate locations.

3.7 RACK ELEVATION AND PATCHING

A. Structured cabling shall be installed in the rack in the following configuration

1. Top Down
2. Fiber infrastructure patch panel installed at the top of the rack.
3. 1U for network switch
4. 2U for patch panel
5. 1U for network switch
6. 2U for patch panel
7. Repeat as many times as required to support actual port count.
8. Only use 1ft patch cords within the MDF/IDF between switches and patch panels.

3.8 FIELD QUALITY CONTROL

- A. Testing: All copper cable channels will comply with, and be tested to current standards for Category 6 channel installations as required by the manufacturer for warranty.
1. Testing of all copper wiring will be performed prior to system cutover.
 2. Contractor is required to notify the Owner three (3) days prior to testing.
 3. 100 percent of the horizontal wiring pairs will be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
 4. Horizontal wiring pairs will be tested from the installed information outlet station cord to the MDF/IDF patch cord.
 5. The Category 6 cable runs will be tested for conformance to the specifications of current TIA 568 Category 6 (channel test).
 6. Category 6 horizontal cables will be tested according to test set manufacturer's instructions utilizing the latest firmware and software.
 - a. The tester will be certified to be in compliance with Category 6 testing standards.
 7. Any pairs not meeting the requirements of the standard, including an asterisk in results, will be accurately documented and immediately communicated with the Owner, the Architect and the General Contractor.
 8. Channels passing with an asterisk are not acceptable and shall be replaced with new product and re-tested.
 9. Contractor will provide two (2) portable media copies to the Owner with the final documentation
 - a. Final documentation must be delivered within five (5) working days of completion of the installation. This is critical for successful implementation of network implementation.
 10. Contractor will provide electronic copies of all test documentation (in PDF and native software format) to the structured cable manufacturer(s) with the final documentation
 - a. Final documentation shall be delivered within five (5) working days.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections shall be performed by the Contractor.
- D. Tests and Inspections:
1. Visually inspect 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-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test twisted pair 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-568-C.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.
- E. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications

Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

- F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.
- I. Should the performance testing show that the installer has not properly completed the systems, the installer shall make all necessary corrections or adjustments and a second demonstration shall be arranged at the installer's expense. Should the Consultant be required to return due to incomplete systems, the installer shall be responsible for the Consultant's fee at \$800 per return visit.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two, 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, 2 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 Thirty, 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

END OF SECTION

SECTION 27 2100

DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Related Documents: General and Supplementary Conditions of the Contract, Division 1 General Requirements, and Drawings are applicable to this Section.
- B. Provide labor to install Owner furnished wireless access points.
- C. Provide labor to install up to (1) Owner furnished network switches.
- D. Provide labor to install (1) Owner furnished edge switch.
- E. Provide labor to install up to (1) Owner furnished uninterruptable power supply (UPS) equipment in the MDF/IDF's.
- F. Provide labor to install up to (2) Owner furnished rack mounted vertical PDU's.
- G. Provide labor to install up to (12) IP phone sets.

1.2 SUMMARY

- A. The following is a summary of the Contractor's Responsibilities and Requirements. The following does not preclude other Contractor Responsibilities and Requirements listed in the specifications.
- B. Review of Contract Documents and field conditions by Contractor prior to the Work.
- C. The Owner makes no representations as to the accuracy or completeness of the site information furnished to the Contractor by the Owner and does not expressly or impliedly warrant same and is not responsible for any interpretations or conclusions reached by the Contractor with respect thereto. It is Contractor's sole responsibility to verify to its own satisfaction all site information.
- D. The Contractor is responsible for having visited the site and ascertained pertinent local conditions such as location, accessibility, and character of the site or building, the character and extent of existing work within and adjacent to the site, and any other work being performed thereon at the time of the submission of his proposal. Any failure to do so will not relieve him from responsibility for successfully performing the work without additional expense to the Owner.
- E. The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies or omissions discovered shall be reported to the Owner at once.
- F. If in the performance of the Contract, subsurface, latent, or concealed conditions at the site are found to be materially different from the information included in the RFP and the resulting Contract Documents, or if unknown conditions of an unusual nature are disclosed differing materially from the conditions usually inherent in work of the character shown and specified, the Owner shall be notified in writing of such conditions before they are disturbed. A/E, with

the approval of the Owner, will promptly make such changes the Specifications as deemed necessary to conform to the different conditions, and any increase or decrease in the Work, or in the time within which the Work is to be completed, resulting from such changes will be adjusted by Change Order subject to the prior approval of the Owner.

- G. Before submitting its proposal to the Owner, and continuously after execution of the Contract, the Contractor shall carefully study and compare this RFP and shall at once report to the Owner any error, inconsistency or omission the Contractor may discover, including any requirements which may be contrary to any law, ordinance, rule, regulation or order of any public authority bearing on the performance of the Work. By submitting its proposal for the Contract and the Work, the Contractor agrees that the RFP and resulting Contract Documents appear accurate, consistent, and complete insofar as can reasonably be determined. If the Contractor has reported in writing an error, inconsistency or omission, has promptly stopped the affected work until otherwise instructed, and has otherwise followed the instructions of the Owner, the Contractor shall not be liable to the Owner for any damage resulting from any such errors, inconsistencies or omissions in this RFP and resulting Contract Documents. The Contractor shall perform no portion of the Work at any time without the Contract Documents and, where required, approved Project Drawings, Product Data or Samples for such portion of the Work.
- H. The Contractor shall perform the Work in accordance with the Contract Documents and submittals.
- I. The Contractor shall arrange for the securing of any and all necessary permits and pay for same.

1.3 WARRANTY

- A. The Contractor warrants to the Owner that all materials and equipment furnished under this RFP will be new unless otherwise specified, and that all Work will be of good quality, free from faults and defects and in conformance with the RFP. All Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. If required by the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.
- B. The Contractor warrants the materials, workmanship and work to be in conformance with the Contract Documents included in this Project, for one full year from date of Acceptance unless a longer warranty or special guarantee is specified. Contractor shall assign to Owner all warranties and guarantees from or rights against any manufacturer, supplier or distributor of equipment, fixtures and other material installed in or incorporated in the Work at the time of Acceptance by owner.
- C. The Warranty binds the Contractor to correct any work that does not conform to such Contract Documents or any defects in workmanship or materials furnished under this Contract which may be discovered within the one-year period. The Contractor shall, at its own expense, correct such defect after receiving notice from the Owner by repairing same to the condition called for in the Contract Documents.
- D. Contractor shall warrantee the repaired/replace item for one year from date of repair/replacement. This warranty shall cover parts, labor, travel and all other expenses.
- E. All replacement, installation, integration, maintenance and testing provided in conjunction with the warranty provisions of such contract will be provided at no additional cost to the Owner.

- F. Warranty service shall be on a 24-hour/day, 365-day/year basis with a response time not to exceed four (4) hours. The respondent shall certify that its proposed service facility shall initiate, within 1 business day, on-site repair to any critical system product that fails while under warranty.

1.4 SERVICE UNDER WARRANTY

- A. If it becomes necessary for the Owner to contract out for warranty repairs, due to an inability or failure of the Contractor to perform such repairs, the Contractor shall reimburse the Owner for all invoices for parts, labor, materials, travel, per-diem, and all other related expenses such as shipping/handling costs to perform such repairs, within 30 days from presentation of an invoice from the Owner. This shall only occur after the Contractor has been given reasonable time and fair opportunity to respond and correct the problem. The cost limitation for such repairs will not exceed the actual costs as listed above which are directly related to the repair.

1.5 SUBMITTALS

- A. Successful contractor will submit electronic copies, of submittal packages via pdf by email or portable storage device within 15 days of written notification to proceed or other written documentation from the Architect or General Contractor. The combined file will be organized into the following sections:
- B. Cover Sheet and Section 1 — Information, Pricing and Material
 - 1. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and contractor work address with a point of contact (POC) and phone number.
 - 2. Pricing shall include detailed breakdown of material quantities, brand, part number, description, unit price, extended total, subtotal for material, and subtotal for labor.
 - 3. Description of work narrative in Word format detailing what is included in your proposal.
- C. Section 2 — Product Data
 - 1. Manufacturer's catalog information showing dimensions, colors, and configurations.
 - 2. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
 - 3. In cases of multiple product numbers on a single cut sheet, the contractor will identify the proper part number with a black X, arrow, or check mark.
- D. Section 3 — Pre-Qualification Certificate
 - 1. Contractor will submit the following documents with project proposal:
 - 2. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
 - 3. Training certificates for design, engineering and installation of the proposed products.
- E. Section 4 — Warranty Documentation
 - 1. Standard manufacturer's warranty unless otherwise noted.
 - 2. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
- F. Section 5 — Record Drawings

1. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. The drawings shall include the following information:
2. All gear and equipment shall be labeled in accordance with the specifications.
3. Provide an example of the required labeling for each item.
4. Provide the MDF and IDF rack elevation details demonstrating the locations network gear and equipment. Show the labeling of such gear and equipment as they will appear in the field.
5. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of all cable testing and will be used as part of the substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.6 MATERIAL AND WORKMANSHIP

- A. The Contractor shall provide and pay for all materials, supplies, machinery, equipment, tools, superintendence, labor, services, insurance, and all water, fuel, transportation, and other facilities necessary for the execution and completion of the work covered by the Contract Documents.
- B. Unless otherwise specifically provided in this Contract, all equipment, material, and articles incorporated in the work covered by this Contract are to be new and of the most suitable grade for the purpose intended.
- C. All work under this Contract shall be performed in a skillful and professional manner. The Contractor agrees to employ only orderly and competent employees, skillful in the performance of the type of work required under this contract; and agrees that whenever informed by the Owner in writing that any employee(s) on the work is (are), in its opinion, incompetent, unfaithful or disorderly, shall be discharged from the work and shall not again be employed on the work without the Owner's written consent.
- D. Materials or work described in words, which so applied, have a well-known technical or trade meaning shall be held to refer to such recognized standards. Neither custom nor usage of trade shall require the Owner to accept materials or workmanship not in strict and complete compliance with the Contract Documents.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Section 01 6600 – Product Storage and Handling Requirements.
- B. Deliver, Storage and Protection
 1. Do not deliver projection screens until building is enclosed, other construction within spaces where screens will be installed is substantially complete, and installation of screens is ready to begin.
 2. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.

1.8 PROJECT CONDITIONS

- A. Project Environmental Requirements
 1. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.

PART 2 - PRODUCTS

2.1 TYPICAL WIRELESS ACCESS POINT

- A. Subject to compliance with requirements indicated herein, provide products of one of the listed manufacturers as identified in the specifications. There will be no substitutions for any of the listed products unless noted otherwise in this document.
- B. Ceiling and wall mounted wireless access point
 - 1. Acceptable Manufacturer: Currently an Owner furnished / Contractor Installed item
 - 2. Model Number: Meraki MR33/74

2.2 NETWORK SWITCH

- A. MDF / IDF
 - 1. Acceptable Manufacturer: Currently an Owner furnished / Contractor installed item
 - 2. Description and Model Number: Cisco Catalyst 2960x
 - 3. Description and Model Number: Cisco Catalyst 4500x

2.3 IP PHONE EQUIPMENT

- A. IP Phone Handset required to be provided and installed at Owner specified locations (coordinate actual locations with Owner point of contact: Joseph Hubbard or Rick Sharp)
 - 1. Acceptable Manufacturer: Currently an Owner furnished / Contractor installed item
 - 2. Description and Model Number: Polycom Soundpoint IP331

2.4 POWER DISTRIBUTION UNIT (PDU)

- A. Currently an Owner furnished / Contractor installed item
 - 1. Description and Model Number: Tripplight – PDU Metered

2.5 UNINTERRUPTABLE POWER SUPPLY (UPS)

- A. MDF / IDF
 - 1. Acceptable Manufacturer: Currently an Owner furnished / Contractor installed item
 - 2. Description and Model Number: Tripplite Smart Pro 15000VA

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate delivery and installation of all Owner furnished equipment with the IT Department point of contact Joseph Hubbard or Rick Sharp.
- B. Coordinate layout and installation of wireless access points with ceiling construction and related components penetrating or above ceilings such as lighting fixtures, mechanical equipment, ductwork, and fire-suppression system.
- C. Coordinate installation of rack mounted UPS equipment with the Owner's IT Department prior to installation.

- D. Coordinate requirements for power supply conduit and wiring required for UPS with the General Contractor.

3.2 INSTALLATION

- A. Comply with provisions of Section 01 73 00 – Execution.
- B. Install device locations as per the technology drawings.
- C. Comply with manufacturer's written instructions at all times.
- D. Provide required brackets, hanger rods, and fasteners as needed for all WAP devices. Devices should not rest on top of the ceiling tiles alone.
- E. Contractors who fail to follow the manufacturer's installation instructions will be required to correct all infractions at the contractor's cost.

3.3 DEMONSTRATION

- 1. Demonstrate operation of the systems to the Owner's designated representatives for as many as systems as the owner dictates.

3.4 PROTECTION

- A. Protect all devices after installation from damage from construction operations. If damage occurs, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.

END OF SECTION

SECTION 274000
SOUND AND PROGRAM SYSTEM EXTENSION

PART 1 - GENERAL

1.1 PROJECT SCOPE

- A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General
- B. All bids shall be based on the equipment as specified herein. Alternate systems will not be accepted.
- C. The contractor shall also provide the FCC registration number of the proposed system.
- D. The contractor for this work shall be held to have read all of the bidding requirements, the general requirements of division 1, and contract proposal forms, and the execution of this work. The contractor will be bound by all of the conditions and requirements therein.
- E. The contractor shall be responsible for providing a complete functional system including all necessary components whether included in this specification or not.
- F. In preparing the bid, the contractor should consider that no claim will be made against the owner for any costs incurred by the contractor for any equipment demonstrations which the owner requests.
- G. This section covers the requirements for an Integrator to design, supply software/equipment for, and install a Campus Communication System. This system is intended to provide audio capabilities including bells, public address announcements, and intercom to various locations throughout the school. The system shall use a data network as the primary means for delivering audio communications. This document covers the material and services necessary to install a Campus Communication System for this project.
- H. Prior to ordering materials or commencing any construction activities, the Integrator shall provide the Owner with a complete bill of materials, including all quantities of software licenses, commissioning, annual maintenance, components, devices, equipment, wiring, and labor required to complete this work. Submit product data, including manufacturer's data sheets for all proposed system components. Submit three copies with all specific items that will be provided clearly indicated and any options highlighted.
- I. This is an extension of an existing Extron Global Viewier Campus Communication Suite. Contractor is required to verify existing system operation prior to demolition or addition of any equipment. Any deficiencies, or inoperable components of the system, shall be logged and transmitted to the Owner. The Contractor shall provide labor and materials for the protection of existing intercom / paging equipment prior to the scheduled demolition. Any equipment removed shall be transmitted back to the Owner for storage during the projects construction schedule. Existing cabling effected by the project demolition shall be protected and / or removed if required.
- J. The Contractor shall provide all labor and materials for the extension of the Extron Global Viewier Campus Communication Suite into the new additions as described within these specifications and the project drawings.
- K. Coordinate with Division 27 0000 as required.

1.2 SUBMITTALS

- A. Specification Sheets shall be submitted on all items including cable types.

- B. Submit outline drawing of system control cabinet showing relative position of all major components.
- C. Shop drawings, detailing integrated electronic communications network system including, but not limited to, the following:
 - 1. Station wiring arrangement.
 - 2. Equipment cabinet detail drawing.
- D. Submit wiring diagrams showing typical connections for all equipment.
- E. Submit a numbered Certificate of Completion for installation, programming, and service training, which identifies the installing technician(s) as having successfully completed the technical training course(s) provided by the system manufacturer.
- F. Submittals shall be in PDF format. Distribution to the Architect through Architects electronic transmittal.

1.3 QUALITY ASSURANCE

- A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
- B. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least 5 years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.
- C. The contractor shall show satisfactory evidence, upon request, that he or she maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain at his or her facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

1.4 SINGLE SOURCE RESPONSIBILITY

- A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and minimum of 30 years experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service school. A certificate of this training shall be provided with the contractor's submittal.

1.5 SAFETY / COMPLIANCE TESTING

- A. The communications system shall bear the label of a Nationally Recognized Testing Laboratory (NRTL) such as ETL, and be listed by their re-examination service. All work

must be completed in strict accordance with all applicable electrical codes, under direction of a qualified and factory approved distributor, to the approval of the owner.

- B. The system is to be designed and configured for maximum ease of service and repair. All major components of the system shall be designed as a standard component of one type of card cage. All internal connections of the system shall be with factory-keyed plugs designed for fault-free connection.
- C. The printed circuit card of the card cage shall be silk-screened to indicate the location of each connection.

1.6 IN-SERVICE TRAINING

- A. The contractor shall provide a minimum of eight hours, not including drive time, of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided at the time of this training.

1.7 WIRING

- A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts.
- B. All communication system wiring shall be labeled at both ends of the cable. All labeling shall be based on the room numbers as indicated in the architectural graphics package.

1.8 PROTECTION

- A. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
- B. The contractor shall note in system drawings, the type and location of these protection devices as well as all wiring information. Such devices are not to be installed above the ceiling.

1.9 SERVICE AND MAINTENANCE

- A. The contractor shall provide a five year equipment warranty of the installed system against defects in material and workmanship. All materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer.
- B. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- C. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

PART 2 - SYSTEM DESCRIPTION

2.1 GENERAL

- A. The system shall provide a complete solution for unifying all campus audio systems with an easy-to-use software interface. Contractor shall provide all labor and materials for the extension of the existing Extron Global Viewier Campus Communication Suite. All new areas, or zones, shall be added to the Extron Global Viewier Campus Communication Suite.

- B. SOFTWARE FUNCTIONAL REQUIREMENTS
 - 1. USER INTERFACE:
 - a. The Contractor is to program and verify new intercom / paging zones are fully operational through the existing user interface. Coordinate with the Owner as required.

 - 2. ADMINISTRATIVE CONTROL:
 - a. The Contractor is to verify that the Campus Communication System shall include user management that allows the System Administrator to control user access of the added components to the system.

 - b. The Campus Communication System shall include location management capability that allows the system administrator to configure codecs and establish announcement zones.

 - 3. INTERCOM:
 - a. The existing Extron Global Viewier Campus Communication Suite shall provide two-way voice communication over the network. Intercom calls may be requested from a communication panel or by the client interface.

 - 4. SOFTWARE HARDWARE REQUIREMENTS
 - a. This system is existing and located within the MDF. Coordinate with Owner IT Group for access.

- C. FIXED EQUIPMENT
 - 1. CLASSROOM WITH AUDIO SYSTEM
 - a. This classroom shall be equipped with an AV system that includes speakers and an amplifier with capacity for an audio line level input. Locations meeting these requirements shall include a communication codec for handling audio encode and decode functions within the room. The codec should be connected to the Campus Communication System data network and have a fixed IP address.

 - b. Acceptable Codec Manufacture: Extron

 - c. Acceptable Codec Model: CC 100C

 - 2. COMMON AREA SMALL
 - a. This is a small common area that requires only a single point of audio communications. Locations meeting these requirements shall include a communication codec for handling audio encode and decode functions. The codec should be connected to the Campus Communication System data

network and have a fixed IP address. This location also requires an amplifier and speakers/s that provide appropriate coverage.

b. Audio amplifier shall be 70v and sized appropriately for the zone and quantity of speakers. Audio amplifier and Codec shall be installed within nearest IDF/MDF. Coordinate with owners IT group and Division 27 0000 as required.

c. Acceptable Codec Manufacture: Extron

d. Acceptable Codec Model: CC 100C

e. Acceptable Amplifier Manufacture: Extron

f. Acceptable 70v Speaker Manufacture: Valcom

g. Acceptable 70v Speaker Model: V-9022A-2

1) Acceptable Alternates:

i. Quam

ii. C2G

3. COMMON AREA LARGE

a. This is a larger common area that requires several points of audio communications amplified from a centralized location. Locations meeting these requirements shall include a communication codec for handling audio encode and decode functions. The codec should be connected to the Campus Communication System data network and have a fixed IP address. This location also requires centralized 70 volt amplifier system, or equivalent, driving multiple speakers that provide appropriate coverage in the target area.

b. Audio amplifier shall be 70v and sized appropriately for the zone and quantity of speakers. Audio amplifier and Codec shall be installed within nearest IDF/MDF. Coordinate with owners IT group and Division 27 0000 as required.

c. Acceptable Codec Manufacture: Extron

d. Acceptable Codec Model: CC 100C

e. Acceptable Amplifier Manufacture: Extron

f. Acceptable 70v Speaker Manufacture: Valcom

g. Acceptable 70v Speaker Model: V-9022A-2

1) Acceptable Alternates:

i. Quam

ii. C2G

4. ADMINISTRATIVE CONTROL

a. A four button control panel shall be installed at the reception counter. This control panel shall be connected to a control processor. The control processor shall be programmed to allow for the activation of pre-recorded messages.

b. Acceptable manufacture: Extron

c. Acceptable Models:

1) CCR 4BLB #70-588-02

- 2) AVEdge 100 #70-1128-02.
- 3) IPL Pro CR88 #60-1416-01

PART 3 - EXECUTION

3.1 DIVISION OF WORK

- A. The conduit, outlets, terminal cabinets, etc., which form part of the rough-in work shall be furnished and installed completely by others. The balance of the system, including installation of speakers and equipment, making all connections, etc., shall be performed by this section. The entire responsibility of the system, its operation, function, testing and complete maintenance for one (1) year after final acceptance of the project by the owner, shall also be by this section.

3.2 ACCEPTABLE MANUFACTURERS - COMPONENTS

- A. MANUFACTURER
 - 1. Extron Electronics
 - 2. 1025 East Ball Road
 - 3. Anaheim, CA 92805
 - 4. 714.491.1500 or 800.633.9876
- B. COMPONENTS:
 - 1. Extron GlobalViewer Enterprise Software
 - 2. Extron GlobalViewer Campus Communication Suite Software
 - 3. Extron GlobalViewer Campus Communication Suite Annual Maintenance
 - 4. Extron GlobalViewer Campus Communication Suite Commissioning
 - 5. Extron CC 100C Campus Communication Codec
 - 6. Extron CC 101P Campus Communication Panel
- C. Substitutions - Exceptions to the specifications are not acceptable. No substitutions are permitted.
- D. All equipment part numbers shall be listed in the bill of materials and the system drawings specifications.

3.3 EXAMINATION

- A. Site Verification of Conditions: Verify that related conditions, including equipment that has been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

3.4 INSTALLATION

- A. Integrator shall furnish all equipment, cabling, labor, system setup, and other services necessary for the proper installation of the products/system as indicated on the drawings and specified herein. System setup information shall include each components proper mounting and alignment and properly verified signal pathways and operation. Proper operational and network support control functions shall be verified.
- B. Plug disconnect: All major equipment components shall be fully pluggable by means of multi-pin receptacles and matching plugs to provide for ease of maintenance and service.

- C. Speaker and telephone lines run above ceiling and not in conduit shall be within J-Hook cable management and attached to the ceiling joist with a maximum spacing of 5' between supports. No wires shall be laid on top of ceiling tile.
- D. Protection of cables: Cables within terminal cabinets, equipment racks, etc., shall be grouped and bundled (harnessed) as to type and laced with No. 12 cord waxed linen lacing twine or T & B "Ty-Rap" cable. Edge protection material shall be installed on edges of holes, lips of ducts or any other point where cables or harnesses cross metallic edge.
- E. Cable identification: Cable conductors shall be color-coded and individual cables shall be individually identified. Each cable identification shall have a unique number located approximately 1-1/2" from cable connection at both ends of cable. Numbers shall be approximately 1/4" in height. These unique numbers shall appear on the As-Built Drawings.
- F. Shielding: Cable shielding shall be capable of being connected to common ground at point of lowest audio level and shall be free from ground at any other point. Cable shields shall be terminated in same manner as conductors.
- G. Mark and label all telephone outlets and/or sets with the graphic room numbers. Label all demarks IDF and MDF points with destination point numbers. Rooms with more than one outlet shall be marked XXX-1, XXX-2, XXX-3, etc. where XXX is the room number.
- H. Install in accordance with manufacturer's handling and installation instructions.
- I. Install in accordance with all local and pertaining codes and regulations
- J. Utilize an Integrator with demonstrated experience in projects of similar size and complexity.
- K. Equipment shall be configured and in ready to use condition at the end of installation.
- L. Energize and commission equipment in accordance with manufacturer's instructions.
- M. Contractor shall provide a minimum of eight (8) hours of operational and programming instruction to school personnel.
- N. On the first school day following installation, the Contractor shall provide a technician to standby and assist in system operation.
- O. Provide complete "in service" instructions of system operation to school personnel. Assist in programming of telephone system.

3.5 GROUNDING

- A. Provide equipment grounding connections for Integrated Telecommunications/Time/Audio/Media System as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- C. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
- D. The contractor shall note in his drawing, the type and locations of these protection devices as well as all wiring information.
- E. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

3.6 DOCUMENTATION

- A. Provide a printed copy of all field programming for all components in system.
- B. Provide a copy of all diagnostic software with copy of field program for each unit.
- C. Provide service manuals, parts list, and internal wiring diagrams of each component of system.
- D. Provide one copy of all field wiring runs, location and end designation of system.

END OF SECTION

**SECTION 27 5313
WIRELESS CLOCK SYSTEMS**

PART 1 - Part 1 – GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

- A. The system is specified as described.
 - 1. Furnish and install a complete new Wireless Clock System using the Primex Wireless XR Wireless Clock System.
 - 2. Furnish and install all system equipment, devices, accessories, and material in accordance with these specifications and drawing to provide a complete and operating system.
 - 3. All bids shall be based on the equipment as specified herein. The model designations are that of Primex Wireless, Inc. The specifying authority must approve any alternate system
 - 4. System shall include the System Devices
 - a. Transmitter (Master)
 - b. Digital Clocks with Accessories

1.2 RELATED SECTIONS

- A. Division 26 "Electrical"
- B. Division 26 Section "Common Work Results for Electrical"
- C. Division 27 Communications

1.3 REFERENCES

- A. System devices specified shall meet or exceed the requirements of the following.
 - 1. National Fire Protection Association (NFPA): 1. NFPA 70 - National Electrical Code (NEC).
 - 2. Manufacturer Installation and User Guides.

1.4 DEFINITIONS

- A. This section provides commonly used terms within this specification.
 - 1. GPS: Global Positioning System, a worldwide system that employs a constellation of satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits Universal Coordinated Time, the world's most accurate and reliable time.
 - 2. NTP: Network Time Protocol, used for synchronizing the clocks on computer networks and devices from either a public server or a separate server on a private local area network.
 - 3. UTC: Universal Coordinated Time

1.5 SYSTEM DESCRIPTION

- A. System shall continually wirelessly synchronize clocks and/or timers, and shall be capable of clock readouts in multiple time zones where desired.

- B. System shall operate on a 72MHz frequency. The 72MHz frequency transmitter efficiently sends time synchronization signals through commercial building materials to ensure all devices receive important time updates, even for Daylight Saving Time and after a power outage.
- C. The system transmitters can be configured with a variety of power output levels to provide coverage for a single building or an entire campus.
- D. The system supports an FCC license for operation of a 72MHz transmitter result in safe and interference free operation for users.
- E. System shall provide wireless time from a master time source. This time source will either be the atomic clock on the GPS system or the clock from a defined NTP server that the system transmitter can access via the customer Local Area Network (LAN). The master time will be synchronized to UTC.
- F. Hard wiring for data communication will not be required to the clocks installed for the system.
- G. Clocks shall automatically adjust for Daylight Saving Time in locations where DST is observed.
- H. Each clock and/or timer and every other component in the system shall use both precise time and synchronized time.
- I. Digital clocks shall be synchronized to within 10 milliseconds every 10 minutes and the system shall have an internal oscillator that maintains plus or minus four seconds per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- J. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day when operating clock strikes 2:01 AM, 6:01 AM, 10:01 AM, 2:01 PM, 6:01 PM, and 10:01 PM, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- K. The system shall include an internal clock reference so that failure to detect the master time source shall not result in the clocks failing to indicate time. Additionally, system transmitters will have an internal battery backup of up to eight hours in the event of a power failure so that settings and the correct master time will be instantly recalled upon restoration of power.
- L. System shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- M. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will “five step” as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
- N. Clock locations shall be as indicated and clocks shall be fully portable, capable of being relocated at any time.

- O. U.S. only: System must operate in accordance with a “Radio Station Authorization”, Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

1.6 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of Manufacturer latest model.
- B. System shall be installed in compliance with local and state authorities having jurisdiction.
- C. U.S. only: The end user will hold a license, known as a “Radio Station Authorization” granted by the FCC. This license grants the end user protected use for wireless transmission at the designated frequency. This license will designate a unique “call sign” for each end user.
- D. U.S. only: Transmitter and receiver shall comply with Part 90 of FCC rules as follows: This device may not cause harmful interference. This device must accept interference received, including interference that may cause undesired operation. Transmitter frequency shall be governed by FCC Part 90.35. Transmitter output power shall be governed by FCC Part 90 257 (b).

1.7 SUBMITTALS

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors, styles, sizes, and finishes of clocks.
- B. Samples: Submit one specified system device model(s) for approval. Approved sample(s) shall be tagged and shall be installed in the work at location directed.
- C. Manufacturer Instructions: Submit complete installation, set-up and maintenance instructions.
- D. Floor plans indicating the location of system transmitter(s), approved by Manufacturer, and device locations will be submitted to Owner prior to installation.
- E. U.S. only: Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.

1.8 SUBSTITUTIONS

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. Other systems requiring wiring and/or conduit between master and clocks and/or timers will not be accepted.
- D. Other systems using wireless technology in an unlicensed frequency range will not be accepted.
- E. Other systems using wireless technology where the license is held by any party other than the end user will not be accepted.

1.9 QUALITY ASSURANCE

- A. U.S. only: Permits: Operating license for the transmitter from the FCC.
- B. Qualifications: Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience including 10 or more years of experience producing GPS wireless time systems.
- C. Installer: Company with documented experience in the installation of commercial time systems.
- D. Prior to installation a site survey must be performed to determine proper transmitter placement.

1.10 DELIVERY STORAGE AND HANDLING

- A. Deliver all components to the site in the Manufacturer original packaging.
- B. Packaging shall contain Manufacturer name and address, product identification number, and other related information.
- C. Store equipment in finished building and in unopened packaging until ready for installation.

1.11 PROJECT SITE CONDITIONS

- A. Clocks and/or Timers shall not be installed until painting and other finish work in each room is complete.
- B. Programmable Count Down Timers: a computer having the specified minimum system requirements for the scheduling software installation will be available for use in programming the timer.
- C. Transmitter - External Antenna: If required, coordinate installation of system antenna for access to the roof to comply with safety standards detailed in Manufacturer instructions and per local codes.

1.12 SYSTEM STARTUP

- A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all system devices and components are functioning.

1.13 WARRANTY

- A. Contractor to provide a Manufacturer to provide a three year warranty on GPS receiver, transmitter, and satellite transmitter. All other devices and components will have a 1 year warranty.
- B. Contractor to provide separate pricing for five-year extended transmitter warranty.
- C. Contractor to provide separate pricing for Manufacturer five-year extended clock warranty.
- D. Contractor to provide separate pricing for Manufacturer extended warranty on system devices.

PART 2 - PART 2 PRODUCTS

2.1 SECTION INCLUDES

- A. The system and equipment is specified as described in this section.
- B. All bids shall be based on the equipment as specified herein. The model designations are that of Primex Wireless, Inc. The specifying authority must approve an alternate system.

2.2 MANUFACTURER

- A. System shall be manufactured by:
 - 1. Primex Wireless, Inc., 965 Wells Street, Lake Geneva, WI 53147 | Phone: (800) 537-0464 | Fax: (262) 248-0061 | Email: info@primexwireless.com | www.primexwireless.com

2.3 SYSTEM OPERATION

- A. The system shall perform in the sequence of operation as described.
 - 1. Configure and install system appliance detailed in Manufacturer installation instructions.
 - 2. Configure and install system devices per model specifications detailed in Manufacturer installation instructions.
 - 3. Transmitter Operation
 - 4. When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the master time source.
 - 5. Master Time Source Operation
 - 6. NTP Time Source: With the transmitter in NTP mode, it connects over the Ethernet to the IP address of the NTP server. This IP address is programmed into the transmitter as part of its configuration. Once the connection to the NTP server is acknowledged, it downloads time data and synchronizes its internal master clock to NTP time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock in this mode once per hour.
 - 7. Clock and/or Timer Operation
 - 8. After initial setup, the clock and/or timer will shut off the receiver. Six times each day an Analog Clock microprocessor will activate the receiver and starting with the stored channel it will again look for a valid time signal. Every 10 minutes a Digital Clock/Timer will activate the receiver and starting with the stored channel it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
 - 9. If an Analog clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Low battery voltage is a common cause of the clock to not properly decode a time signal. If a clock goes into step mode, replace the batteries first and then determine if the clock synchronizes to master time source before attempting other troubleshooting methods.
 - 10. If a Digital Clock/Timer has not decoded a valid time signal for a pre-determined number of days, the display colon indicator will flash continuously until a valid time signal is received.

2.4 EQUIPMENT

- A. The system shall include all equipment as specified.
 - 1. Transmitter Equipment
 - 2. Digital Clocks

3. Dual Mounting Bracket
 4. Wire Guards
- B. Transmitter Equipment:
1. Levo XR Series XRO1LM 1 Watt Transmitter (49 channel) Internal NTP and GPS
 - a. Transmitter 1 Watt
 - b. Transmitter shall meet the specifications below:
 - i) 1-Watt maximum transmission (at transmitter)
 - ii) 72MHz frequency range
 - iii) 49 channels available (pre-programmed prior to shipping)
 - iv) Daylight Saving Time bypass switch
 - v) Time zone adjustment switch (pre-programmed on XR01E prior to shipping)
 - vi) display for time, date, and signal verification
 - vii) Dimensions: 17.0"L x 12.0"W x 1.7"D (43.2cm x 30.5cm x 4.32cm)
 - viii) Power Supply: Input: 120 VAC, 50/60 Hz, 0.6 Amp | Output: 9 VDC, 2.78 Amp (6 ft. cord, 1.83m)
 - ix) Operating Range: 32°- 122°F (0° - 50°C)
 - x) Transmitter with Internal Antenna
 - c. Transmitter shall transmit time continuously to all clocks in the system.
 - d. Internal clock: Transmitter shall contain an internal clock such that failure to update time from source will not disable the operation of the clocks.
 - e. Transmitter shall include a surge suppressor/battery backup and a mounting shelf.
 - f. Transmitter shall have the following switches
 - i) Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
 - ii) Switch to allow the following configuration: Daylight Saving Time bypass option, 12-hour or 24-hour display, GPS or NTP time source, Local or LAN configuration, UTC+ or UTC-, 30-minute UTC offset option CANADA (for Newfoundland).
 - g. Transmitter housing shall incorporate a display, which shall include the following:
 - i) Time readout
 - ii) AM and PM indicator if 12-hour time display is set
 - iii) Day and date readout
 - iv) Time zone indicator including Standard or Daylight Savings Time
 - v) On screen menu to verify diagnostics, errors, time updates, and switch settings, toggled by sequence of push buttons next to display.
 - vi) Status LEDs: The LED signal indicator consists of three visual LEDs that indicate the status of the transmitter. The green LED indicates one of the three statuses, including (1) solid green: transmitter is transmitting, (2) not illuminated: transmitter has not received an initial time signal after power up and/or reset, and (3) flashing: transmitter is not broadcasting due to standby mode or there is a condition that is causing the transmitter not to broadcast properly. The yellow LED indicates one of the two statuses, including (1) not illuminated: no warning conditions, (2) flashing: transmitter has not received a time update for 48 hours or a 1PPS (one pulse per second) has not been detected within the last 48 hours. The red LED indicates one status, (1) solid red: defined error condition exists.
- C. Digital Clocks shall meet the following specifications.

1. Digital Clock must be able to receive synchronized time signal from the master or satellite transmitter.
 2. Digital Clock display must include a 12 or 24-hour time display, a PM indicator light, and an alternating time and date display option.
 3. Surface-mount models are available from the Manufacturer.
 4. Flush-mount models are available from the Manufacturer.
 5. Dual-mount models are available from the Manufacturer.
 6. Digital Clock shall be capable of automatically adjusting for Daylight Saving Time.
 7. Digital Clock shall have either a 120 VAC or 24 VAC power supply built into the clock assembly.
 8. 120 VAC Digital Timer will include a power cord with a plug or a cord with pigtail.
 9. 24 VAC Digital timer will include a power cord with pigtail to be hard wired to building 24VAC power grid.
 10. Digital Clock must be viewable from 150 feet (45.7m).
 11. Digital Clock must have highly visible 7-segment LED digits.
 12. Digital Clock shall have three display dimmer options, 75%, 50%, and 25%.
 13. Digital Clock LED colors, sizes, digit layouts, and mount options are available from the Manufacturer.
- D. SUPPLY MODELS - Digital Clocks (Levo XR Series) # XRA7A201
1. Surface Mount with 4" Digits
 2. 4-Digit, 120VAC, 4° Slope Bracket, 10' (3.0m) cord with plug
- E. System shall include the accessories below:
1. Digital Clock - Dual Clock Bracket Kit
 - a. 4XBRK- Wall | 2", 4-Digit | 2", 6-Digit | 4", 4-Digit
 2. Digital Clock Wire Guards
 - a. 4389 Digital Wire Guard, 4" (10.16cm), 4- or 6-digit installed within the gymnasium.
 3. 1-Watt Transmitter Rack
 - a. 18 GA metal
 - b. Epoxy coated
 - c. 18"L x 3"H x 16.5"D (45.7cmL x 7.6cmH x 41.9cmD)
 - d. Model # XR01AP Transmitter accessory pack - transmitter Rack and UPS

PART 3 - PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions with the Installer present for compliance with requirements and other conditions affecting the performance of the system and the system devices.
- B. Do not proceed until unsatisfactory conditions have been corrected.
- C. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- D. Verify that 120-volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.
- E. Code Blue and Elapsed Timer: Verify single gang electrical box for switch control is mounted and within 15 feet (4.5m) of elapsed timer. Verify pathway for connecting cable is available and compliant to local building codes.

- F. AC-powered devices: Verify that electrical power outlet is near location of clock or timer and the outlet is operational and properly grounded

3.2 INSTALLATION

- A. General: Install system devices in accordance with applicable codes.
- B. Install system devices in accordance with Manufacturer written instructions.
- C. Provide all system equipment necessary for a complete and operable system.
- D. Comply with requirements of Division 27 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling."
- E. Cables: Install cables in raceways and cable trays except within consoles, cabinets, and desks [and except in accessible ceiling spaces and framed partitions where exposed wiring is allowed by Owner]. Install plenum cable where required. Conceal cable installation where possible.
- F. Prior to purchase and installation of equipment, Contractor to contact Primex Wireless Technical Support at (1-800) 404-8112 for a site survey completed by the manufacture.
- G. If NTP will be used as master time source:
- H. Connect CAT5/CAT5e/CAT6 EIA/TIA standard Ethernet cable from transmitter LAN port to available network drop.
- I. Set GPS/LAN DIP switch to NTP.
- J. Transmitter (INTERNAL Antenna only)
 - 1. Locate transmitter where indicated, a minimum of 2 to 3 feet (.6 to 1 meter) above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
 - 2. Transmitter(s) will be placed at locations indicated within specifications and drawings.
 - 3. Connect antenna to transmitter, using care not to strip threads.
 - 4. Connect power supply to the transmitter.
 - 5. Set the channel number on the display to correspond to the FCC license.
 - 6. Plug power supply into electrical outlet.
- K. Digital Clocks
 - 1. Cable routing must comply with ANSI EIA/TIA- 569-A and local building codes.
 - 2. Furnish all equipment necessary for a complete and operational system.
 - 3. Perform the following operations with each clock:
 - a. Configure and set clock to correct time in accordance with manufacturer instructions.
 - b. Observe clock until valid signals are received and clock adjusts itself to correct time.
 - c. Install each clock per its model mounting specifications per manufacturer instructions and mounting instructions at the indicated location.

3.3 FIELD INSPECTION

- A. Inspection: Make observations to verify that system devices and components are properly labeled.

- B. Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts which are found defective.
- C. At completion of system device installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that the system and all system devices and components are functioning.
- D. Wire Guards
 - 1. Secure to wall, using approved theft-resistant fasteners.

3.4 MANUFACTURER SERVICES

- A. System installation guides shall be provided.
- B. If needed, provide technical assistance as demonstrated in the manufacturer guides, on product start-up and system setup, to owners or installers representatives via phone, fax, or email.

3.5 CLEANING

- A. Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by Manufacturer.
- B. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.6 DEMONSTRATION

- A. Provide training to Owner's representative on setting, adjusting and configuring device and routine maintenance.
- B. Provide training to Owner's representative on installing the software, adjusting and programming the transmitter, setting and adjusting system devices and routine maintenance

3.7 PROTECTION

- A. Protect finished installation until final acceptance of the project.

3.8 TESTING

- A. All devices must be tested at their operational location under normal operational conditions to assure reception of signal.

END OF SECTION

SECTION 28 05 00

GENERAL FIRE ALARM SYSTEM REQUIREMENTS

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.
- B. Fire alarm system complete including selective modification of the existing system to be revised and expanded, cabling, special backboxes, hardware and all other required devices and equipment.
- C. Installation of system equipment per specifications.
- D. Supply in a timely manner to the electrical contractor special backboxes for installation as required.
- E. Coordinate wireway, raceway, power, and outlet requirements with the builder and the electrical contractor.
- F. Fire Alarm Systems Contractors shall provide and install prior to cable installation plastic snap in bushings at each box opening, passage through a metal stud, and at the end of all open conduit stubs or sleeves to protect the cabling from damage.
- G. Furnishing of all required materials, equipment, tools, scaffolding, labor, and transportation necessary for the complete installation of the fire alarm systems as shown on the drawings and as specified herein.
- H. Cable pathways, conduit, and cable support systems shall be complete with bushings, deburred, cleaned, and secure prior to installation of cable.
- I. It is the intent of these specifications to provide complete installations although every item necessary may not be specifically mentioned or shown.

1.2 WORK TO BE INCLUDED BY THE ELECTRICAL CONTRACTOR IN BASE CONTRACT PROPOSAL

- A. Provide utility services conduit as outlined on drawings as required.
- B. All required conduit for accessibility to attic space.
- C. Furnishing and installation of all required standard back boxes and conduit.
- D. Installation of special back boxes supplied by Division 28 contractor(s).
- E. Furnishing and installation of all floor boxes, surface raceways, and other wireways which are detailed or specified under Division 26.
- F. Provide equipment-mounting boards as outlined on drawings.
- G. Provide equipment grounding system, conductors, and bus bars and as outlined in Division 26.

- H. Provide 120-volt power and hook-up to equipment provided in Division 28.
- I. Coordination of requirements of Division 28 with the Builder.

1.3 WORK NOT INCLUDED

- A. Contractors shall make no agreement that obligates the Owner to pay any company providing communications, monitoring, or other services. Contractors shall not make selection, purchase, or installation of interconnect instruments/equipment to be used on this project.

1.4 RELATED SECTIONS

- A. The conditions of the Division 0, Division 1, Division 26 requirements, and the contract requirements that include the General Conditions and the Supplementary Conditions apply to work of this division.
- B. Section 26 05 34 - Provisions For Communication, Security & Safety Systems.

1.5 CODES, STANDARDS, AND THEIR ABBREVIATIONS

- A. General:
 - 1. Perform all work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are exceeded by the contract documents.
 - 2. In addition to the requirements outlined in other sections of the specifications the following standards are imposed as applicable to the work in each instance:
 - a. OSHA Safety and Health Regulations for Construction.
 - b. NFPA No. 70 National Electrical Code.
 - c. NESC National Electrical Safety Code, ANSI Standard C2.
 - d. NEIS National Electrical Installation Standards.
 - e. Local Codes and Ordinances.
- B. Where local codes or practices exceed or conflict with the NEC, it shall be the Contractor's responsibility to perform the work in accordance with the local code prevailing and local interpretations thereof. Any such additional work shall be performed at no additional cost to the Owner.
- C. Materials and components shall be UL listed and labeled by Underwriters Laboratories, Inc. for the intended use under the latest appropriate testing standard.
- D. The Contractor shall obtain all permits required to commence work. Upon completion of the Work, the Contractor shall obtain and deliver to the Owner's Representative a Certificate of Inspection and Approval from the State Board of Fire Underwriters, the City of Jarrell, Texas, and other authorities having jurisdiction. The Contractor shall pay required permit fees.

1.6 LIST OF ASSOCIATIONS AND STANDARDS:

ADA:	Americans with Disabilities Act.
ANSI:	American National Standards Institute, 1430 Broadway; New York, NY 10018.
ASTM:	American Society for Testing and Materials, 1916 Race Street; Philadelphia, PA 19103.
BICSI:	(RCDD5 Standards), 8610 Hidden River Parkway, Tampa, FL 33637
CBM:	Certified Ballast Manufacturers Association, 2116 Keith Building; Cleveland, Ohio 44115.

IEEE:	Institute of Electrical and Electronics Engineers, 345 East 47th Street; New York, NY 10017.
ICEA:	Insulated Cable Engineers Association, P.O. Box P, South Yarmouth, MA 02664.
NEC:	National Electrical Code; NFPA No. 70.
NECA:	National Electrical Contractors Association, Inc., 7315 Wisconsin Ave.; Washington, DC 20014.
NEMA:	National Electrical Manufacturers Association, 155 East 44th Street; New York, NY 10017.
NESC:	National Electrical Safety Code, ANSI Standard C2.
NFPA:	National Fire Protection Association, 60 Batterymarch Street; Boston, MA 02110.
OSHA:	Occupational Safety and Health Administration, US Department of Labor; Washington, DC 20402.
TAS:	Texas Accessibility Standards (TAS) Article 9102.
UL:	Underwriters Laboratories, Inc., 333 Pfigsten Road; Northbrook, IL 60062.

- A. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes.
- B. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.
- C. The date of the code or standard is that in effect on the date of issue stated on the contract documents, except when a particular publication date is specified.
- D. The Contractor shall comply with all State, Federal, NFPA, local codes and ordinances that may alter any part of the plans or specifications. The Contractor shall bear all costs for correcting any deficiencies due to non-compliance.
- E. Where local codes and ordinances are not in writing or on record but local precedence have been set, the Owner shall pay for any additional resulting cost.

1.7 DEFINITIONS

- A. Approval: It is understood that approval must be obtained from the Architect in writing before proceeding with the proposed work. Approval by the Architect of any changes, submitted by the Contractor, will be considered as general only to aid the Contractor in expediting his work.
- B. The Builder: The primary contractor engaged to oversee the construction project. They may be technically described as a Construction Manager, General Contractor, Managing Construction Contractor, et cetera.
- C. The Contractor: The Contractor engaged to execute the work included a particular section only, although he may be technically described as a Subcontractor to the Builder. If the Contractor, engaged to execute said work, employs Sub-Contractors to perform various portions of the work included under a particular Section, they shall be held responsible for the execution of this work, in full conformity with Contract Document requirements. The Contractor shall cooperate at all times and shall be responsible for the satisfactory cooperation of his Subcontractors with the other Contractors on the job so that all of the various sections and phases of work may be properly coordinated without unnecessary delays or damage.
- D. The Electrical Contractor: The Electrical Contractor shall be engaged to execute the work included Division 26 only.

- E. PDF file or .pdf: The filename extension associated with “Portable Document Format” files, which are multi-platform computer files in the ISO 32000-1:2008 open standard format developed and licensed by Adobe Systems. These files are a digital electronic representation of text, documents, images, and technical drawings in a font and color-accurate fixed-layout format that is platform and display resolution independent. PDF files can be electronically transmitted, viewed, or printed with various free PDF reader application programs, and may allow markups/comments with various PDF editing application programs.
- F. Provide: Defined as requiring both the furnishing and installation of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

1.8 SCHEDULE OF VALUES, APPLICATION FOR PAYMENT

- A. The Contractor shall in accordance with the General Provisions of the Contract, including General and Supplementary Conditions, and Division 1, complete a Schedule of Values and Applications for Payment. When a portion of this work separately funded, including donations or E-Rate, the contractor shall accommodate this in the Schedule of Values and Applications for Payment. For E-Rate eligible portions of this work, the contractor will be required to participate in the E-Rate program, comply with all E-Rate regulations, and provide billing as needed. The contractor shall coordinate with the Owner to file Form 471 or latter edition and/or other forms as may be required.

1.9 WARRANTY

- A. The Contractor shall warranty his work against defective materials and workmanship for a period of one year from date of acceptance of the job.
- B. Neither the final payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.
- C. He shall remedy any defects due thereto, and pay for any damage to other work resulting there from, which shall appear within a period of one year from date of substantial completion.
- D. The Owner shall give notice of observed defects with reasonable promptness.
- E. This Warranty shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.10 SITE VISIT

- A. Before submitting a proposal, each proposed contractor shall examine all plans and specifications relating to the work, shall visit the site of the project, and become fully informed of the extent and character of the work required, including all required utilities.
- B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.11 SUBMITTALS

- A. Submittal procedures shall be per Division 1 - General Requirements.
- B. Provide a complete submittal for each section as specified.

- C. Submit complete submittal package within 30 calendar days after award of this work for approval. Equipment is not to be ordered without approval. Partial submittals are not acceptable for review. Each submittal shall include a dated transmittal.
- D. A submittal may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- E. Each Product data submittal shall include:
 - 1. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting sub-contractor. Include on or after the cover sheet sufficient space for review stamps.
 - 2. An indication of any deviations from Contract Document requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
 - 3. A product data index and complete equipment list including for each product submitted for approval the manufactures name and part number, including options and selections.
 - 4. Cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by prominent notation (an arrow, circle, or other means) on each sheet the exact product and options being submitted.
 - 5. Submit design data, when the scope of work requires, including calculations, schematics, risers, sequences, or other data.
 - 6. When the contract requires extended product warranties, submit a sample of warranty language.
 - 7. Any resubmittal shall include a complete revised equipment list and any product data that is revised.
- F. Submit shop or coordination drawings, when specified or the required for the scope of work, which include information that will allow to the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product. Shop or coordination drawings shall be specifically prepared to illustrate the submitted portion of work, this may require diagrams, schedules, details, and accurate to scale equipment and device layouts prepared using a CAD or BIM engineering drawing program.
- G. The Engineer's review of submittals is only for confirmation of adherence to design of project and does not relieve the Contractor of final responsibility for furnishing all materials required for a complete working system and in complying with the Contract Documents in all respects.

1.12 PROJECT RECORD DOCUMENTS

- A. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building.
- B. Upon submitting his request for final payment, he shall turn over to the Architect/Engineer, for subsequent transmittal to the Owner revised plans showing "as installed" work.
- C. In addition to the above, the Contractor shall accumulate during the jobs progress the following data in PDF file format (preferred) or paper copies to be turned over to the Architect/Engineer for checking and subsequent delivery to the Owner:
 - 1. All warranties, guarantees, and manufacturer's directions on equipment and material covered by the Contract.
 - 2. PDF file or paper copies of all Shop Drawing prints and CAD or BIM engineering drawing program files.

3. Any software programs, data/programming files, passwords, special interface cables, or keys that may be needed to maintain or access equipment.
4. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
5. Any and all other data and/or plans required during construction.
6. Repair parts lists of all major items and equipment including name, address, and telephone number of local supplier or agent.
7. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
 - a. Builder and all Contractors.
 - b. Major Equipment Suppliers
 - c. Submit communication systems warranties.

1.13 TRAINING

- A. Upon completion of the work and at a time designated by the Architect, provide formal training sessions for the Owner's operating personnel to include location, operation, and maintenance of all fire alarm systems equipment and systems.
- B. See other sections for time requirements.

1.14 PLANS AND SPECIFICATIONS

- A. The intent of the project drawings is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.
- B. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
- C. Install the work complete including minor details necessary to perform the function indicated. Provide fire alarm systems (including all hook-ups) complete in every respect and ready to operate.
- D. If clarification is needed, consult the Architect/Engineer.
- E. Review pertinent drawings and adjust the work to conditions shown. Where discrepancies occur between drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer for his interpretation.
- F. The Architect/Engineer reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.

1.15 PRODUCT SUBSTITUTIONS:

- A. Descriptions and details, acceptable manufacturers' names listed, and specific manufacturer and model number items indicated in the plans and specifications shall establish a standard of quality, function, and design. Manufacturers and model numbers listed "no exceptions" shall not be substituted without specific notice in an addendum. Otherwise, where a specific manufacturer's product is indicated, products of other manufacturers listed as acceptable may be submitted for approval based on the substitute product being, in the opinion of the Engineer, of equivalent or better quality than that of the product specified.
- B. Proposed contractors wishing to propose systems which differ in manufacturer, features, functions, or operating characteristics from those outlined in these specifications must do so in writing to the specifying authority at least ten (10) days prior to the proposal opening.

- C. For manufacturers equipment or models other than that specified, the proposed contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment. Proposals must include detailed information showing all deviations from the system as specified and include relevant technical and cost data. This shall include a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.
- D. The Engineer will consider all such submittals and the Architect will issue an addendum listing items that the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.
- E. Substitute products for which the proposed contractor does not obtain prior approval will not be considered acceptable for this project. Final approval of the alternate system shall be based on the decision of the Owner and Architect. Prior approval to make a proposal for this project does not automatically ensure the system will be an acceptable equivalent.
- F. The Contractors' proposal represents that the contract proposal price is based solely upon the materials, equipment, and labor described in the Contract Proposal Documents (including addenda, if any) and that he contemplates no substitutions or extras.
- G. The manufacturer of the proposed substitute unit shall provide samples for evaluation, when required, at no charge and non-returnable.
- H. Requests for substitution are understood to mean that the Contractor:
 - 1. Has personally investigated the proposed substitution and determined that it is equivalent or superior in all respects to that specified.
 - 2. Will provide the same guarantee for the substitution that he would for that specified.
 - 3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.
 - 4. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances:
 - a. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
 - b. The specified product is unavailable through no fault of the Contractor.
 - c. The manufacturer refuses to warranty the specified products as required.
 - d. Subsequent information indicates that the specified product is unable to perform properly or to fit in the designated space.
 - e. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.
 - f. Revisions to the electrical system caused by substitutions shall be under the supervision of the Engineer, at a standard hourly rate charged by the Engineer. Charges from the Engineer, Architect, and Electrical Contractor shall be paid by the Contractor originating the changes.

1.16 FUTURE USE CABLING

- A. When cabling is installed for future use, it shall be identified with a tag of sufficient durability to withstand the environment involved.
- B. Locations and Existing Conditions:
 - 1. Location and condition of any existing equipment or services, when shown, have been obtained from substantially reliable sources, are shown as a general guide only, without guarantees as to accuracy.
 - 2. The Contractor will examine the site, verify all requirements, service points, and availability of all services required to complete this project. No consideration will be

granted for any alleged misunderstanding of the materials and labor to be provided as necessitated by nature of the site including those items that may be fairly implied as essential to the execution and completion of any and all parts of this project.

1.17 SELECTIVE MODIFICATION OF THE EXISTING FIRE ALARM SYSTEM TO BE REVISED AND EXPANDED,

- A. As indicated by the plans and specifications the fire alarm contractor shall be responsible for selective modification of the existing system to be revised and expanded, including demolition of any devices and cabling previously abandoned. Demolition shall include:
 - 1. Disconnection and removal of all fire alarm devices not to remain in service in walls, floors, and ceilings.
 - 2. Identification and verification of abandoned wiring and equipment. All disconnected or abandoned devices that are visible shall be removed, i.e. non-functional fire pulls, bells, speakers, signals, et cetera. Remove abandoned wiring to the source of the supply everywhere possible, the accessible portions of all inaccessible abandoned cabling shall be removed.
 - 3. Removal of exposed abandoned conduit and supports including brackets, stems, hangers, and other accessories located on walls and above accessible finished ceilings. Cut abandoned conduit flush with walls, floors, etc., and patch surfaces.
 - 4. Provide a blank cover for abandoned device backboxes that are impractical to remove from masonry construction without unnecessary damage.
 - 5. Confirm with Owner/Architect regarding the handling and disposal/reuse of removed material, equipment, devices, et cetera.
 - 6. Off-site disposal in a legal manner of all materials not requested to be turned over to the Owner. Comply with government regulations pertaining to environmental protection, and disposal of materials and equipment. Do not burn any materials on the site.
 - 7. Repair of any finishes or adjacent construction damaged during modification, extension, and demolition work.

1.18 EXAMINATION

- A. Verify field conditions including existing systems, equipment models, configurations, circuiting arrangements, cabling, and devices. Adjust all circuiting, cabling, and materials to be provided as required by job conditions.
- B. Project drawings are based on casual field observation and existing record documents when available, report any significant discrepancies to the Engineer before disturbing existing systems.
- C. The Contractor accepts the existing conditions when beginning demolition.

1.19 IMPLEMENTATION

- A. Verify phasing in regard to systems and coordinate before energizing any system.
- B. When required during phases of construction to maintain existing systems in service in particular areas, provide temporary wiring and connections as necessary to accommodate construction.

1.20 OPERATION OF NEW EQUIPMENT PRIOR TO PROJECT COMPLETION

- A. When the phasing of a project requires that fire alarm systems are operable in certain areas and the Owner needs to operate the equipment the contractor shall make such provisions. The warranty period shall commence on new equipment when it is operated for the beneficial use of the Owner. Regardless of whether or not the equipment has or has not been operated,

the Contractor shall properly clean the equipment, properly adjust, and complete all punch list items before final acceptance by the Owner. In these cases, the date of acceptance and the start of the warranty may be different dates.

1.21 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment in areas of renovation that are to remain or be reused.

1.22 PROTECTION OF EQUIPMENT AND MATERIALS

- A. The Contractor shall take such precautions as may be necessary to protect his apparatus from damage.
- B. This shall include the creation of all required temporary shelters to protect any apparatus above the floor of the construction and the covering of apparatus in the completed building with tarpaulins or other protective covering.
- C. Failure to comply with the above to the satisfaction of the Owner's inspector will be sufficient cause for the rejection of the equipment in question and its complete replacement by the Contractor.

1.23 FINAL OBSERVATION

- A. It shall be the duty of the Contractor to make a careful observation trip of the entire project, assuring themselves that the work on the project is ready for final acceptance before calling upon the Architect/Engineer to make a final observation.
- B. To avoid delay of final acceptance of the work, the Contractor shall have all necessary bonds, warranties, receipts, affidavits, et cetera, called for in the various articles of these specifications, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and shall deliver the same to the Architect/Engineer at or before the time of said final observation. The Contractor is cautioned to check over each bond, receipt, et cetera, before preparing for submission to verify that the terms check with the requirements of the specifications.
- C. The following and other provision of Division 1 General Conditions will be required at time of final completion:
 - 1. Final clean up completed.
 - 2. All systems are fully operational, all material and devices installed.
 - 3. As built (as installed) drawings and operations manuals.

1.24 PROHIBITED MATERIALS

- A. No new asbestos, lead, or materials containing these substances shall be permitted in this project. The Contractor shall consult the Architect concerning these materials if their presence is suspected. All work in or around existing asbestos or lead materials is at the sole risk of the Contractor and his personnel.

1.25 CUTTING AND PATCHING

- A. Notify the Builder sufficiently ahead of construction of any floors, walls, ceiling, roof, et cetera, of any openings that will be required for his work.
- B. The Contractor shall see that all sleeves required for his work are set at proper times to avoid delay of the job.

- C. All necessary cutting of walls, floors, partitions, ceilings, et cetera, as required for the proper installation of the work under this Contract shall be done at the Subcontractor or at the Subcontractor's expense in a neat and workmanlike manner, and as approved by the Architect/Engineer.
- D. Patching of openings and/or alterations shall be provided by the fire alarm Subcontractor or at the Subcontractor's expense in an approved manner.
- E. No joists, beams, girders, or columns shall be cut by any Contractor without first obtaining written permission of the Architect/Engineer.
- F. All openings in firewalls and floors shall be completely sealed after installation for a completely airtight installation. Sealing material shall be non-combustible and UL approved. The installed sealing assembly shall not cause the fire rating of the penetrated structure to be decreased.
- G. All openings in exterior walls shall be sealed watertight.
- H. Seal voids around conduits penetrating fire-rated assemblies and partitions using fire stopping materials and methods in accordance with NFPA and local codes.

1.26 MANUFACTURERS' INSTRUCTIONS

- A. All equipment and devices shall be installed in accordance with the drawings and specifications, manufacturer's instructions, and applicable codes.
- B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions.
- C. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.27 INSTALLATION

- A. Cooperation with trades of adjacent, related or affected materials or operations, and or trades performing continuations of this work under subsequent contracts are considered a part of this work. In order to effect timely and accurate placing of work and to bring together, in the proper and correct sequence, the work of such trades, including work provided under a Division 1 allowance.
- B. The Fire Alarm Contractor shall coordinate installation of the fire alarm systems with the Builder, Electrical, Mechanical, and Plumbing Contractors to ensure a complete working system for the Owner.
- C. Where required for accessibility all conduit and boxes for all fire alarm systems shall be provided by the Electrical contractor as specified, including systems in Division 28, any and all allowances shall be included. Normally low voltage wiring shall run open and supported in accessible attic space. All low voltage wiring in exposed areas such as gyms, stages, shops, and field houses shall be enclosed in conduit. Coordinate with, and verify with Division 26 to provide required conduit and boxes at locations and heights as required.
- D. Conduit, innerduct, track, or raceway shall conceal and protect wiring in exposed areas, within walls, through in- accessible areas, floors, chases, under slab, crawlspaces, or underground.

- E. All conduit, duct, track, and raceway runs shall be spaced apart to allow for maintenance, such as the installation of couplings, without disturbing adjacent pathways.
- F. All work must be performed by workers skilled in their trade. The installation must be complete whether the work is concealed or exposed.
- G. Provide stainless screw/bolt hardware wherever stainless devices are used and in potentially wet areas.
- H. Coordinate the actual locations of devices and outlets and equipment with building features and mechanical equipment as indicated on architectural, structural, and mechanical drawings. Review with the Architect any proposed changes in outlet or equipment location. Relocation of devices, before installation, of up to 3 feet from the position indicated, may be directed without additional cost. Remove and relocate outlets placed in an unsuitable location when so requested by the Architect.

PART 2 – PRODUCTS

- A. Not Applicable

PART 3 – EXECUTION

- A. Not Applicable

END OF SECTION

SECTION 28 1300

ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

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. Contractor shall furnish and install additional access control components as indicated on the contract drawings to extend the Owner's existing system to the added and renovated sections of the middle school.
- B. Section Includes:
 - 1. Security access central-control station.
 - 2. One or more security access networked workstations.
 - 3. Security access operating system and application software.
 - 4. Security access controllers connected to high-speed electronic-data transmission network.
- C. Related Requirements:
 - 1. Section 281500 "Access Control System Hardware Devices" for access control system hardware, such as keypads, card readers, and biometric identity devices.

1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.

- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.
- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Workstation operating system documentation.
 - 2. Workstation installation and operating documentation, manuals, and software for the workstation and all installed peripherals. Software shall include system restore, emergency

- boot diskettes, and drivers for all installed hardware. Provide separately for each workstation.
- 3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on USB media of the hard-copy submittal.
- 4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Contractor
 - 1. The Contractor, as a business entity, shall be an authorized, certified representative/dealer of the specified system for a period of three (3) years.
 - 2. The Contractor must have previously established offices located within 120 miles of the project location.
 - 3. The Contractor shall be capable of responding to a service call within four (4) hours.
 - 4. The Contractor shall be capable of initiating proposed services by dispatching technicians to repair a system within one (1) calendar / business day of a service request.
 - 5. The Contractor shall not have any grievances, license violations or complaints of record regarding workmanship, code compliance, or service response.
 - 6. The Contractor shall have a minimum of five (5) years of experience with the installation and project management of similar sized solutions.
 - 7. All programmers assigned to this project must have a minimum of (3) years of programming experience with the proposed solution and a current training certificate.
- C. Sub-Contractors
 - 1. The use of subcontractors must be approved by the Owner in writing.
 - 2. All subcontractors shall meet the same licensing, certification and experience requirements of the specified system.
- D. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
 - 1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
 - 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
 - 3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
 - 4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.8 PROJECT CONDITIONS

- A. The Contractor shall perform the work in accordance with the contract documents and field conditions prior to work.
- B. The Owner makes no representations as to the accuracy or completeness of the site information furnished to the Contractor and does not expressly or impliedly warrant same and is not responsible for any interpretations or conclusions reached by the Contractor with respect thereto. It is Contractor's sole responsibility to verify, to its own satisfaction, all site information.
- C. Project Environmental Requirements
 - 1. Do not begin installation until instructed to perform by the Owner Representative.
 - 2. While on any property owned by the Owner, all Contractors shall comply with Owner policies concerning alcohol, tobacco, electronic cigarettes, open-carry and/or concealed firearms as well as Owner policy governing dress, behavior etc.
 - 3. Owner approved badges, if required, will be displayed at all times while on site. Personnel found without their badges on them or who refuse to display them properly will be removed from the job site immediately.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SOFTWARE

- A. Acceptable manufacturer: Kantech Entrapass

2.2 DESCRIPTION

- A. Security Access System: Workstation-based central station and field-installed controllers, connected by a high-speed electronic-data transmission network.

2.3 SYSTEM DATABASE

- A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device. Contractor shall extend the existing system to include the new facility.
- B. Database Operations:
 - 1. System data management shall be in a hierarchical menu-tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
 - 2. Navigational Aids:
 - a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
 - b. Point and click feature to facilitate data manipulation.
 - c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
 - d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.

3. Data entry shall be automatically checked for duplicate and illegal data and shall be verified for valid format.
4. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose for which the item was entered, reasons for changes that were made, and the like.

2.4 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.5 CENTRAL-STATION HARDWARE

- A. Redundant Central Computer:
 1. This is not required for this project.
- B. Desktop Workstations:
 1. No desktop workstations are required for this project.
- C. Portable Workstations:
 1. No portable workstations are required for this project.
- D. Printers:
 1. No printers are required for this project.

2.6 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Entry-Control Controller:

1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
 - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
 - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
 - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
 - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
2. Inputs:
 - a. Data from entry-control devices; use this input to change modes between access and secure.
 - b. Database downloads and updates from the central station that include enrollment and privilege information.
3. Outputs:
 - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
 - b. Grant or deny entry by sending control signals to portal-control devices[and mask intrusion-alarm annunciation from sensors stimulated by authorized entries].
 - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
 - d. Door Prop Alarm: If a portal is held open for longer than 15 seconds alarm sounds.
4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
 - a. Store, up to the maximum number of transactions allowed by the manufacturer, during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

- a. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
 - b. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
 - 1) Trouble Alarm: Normal power-off load assumed by battery.
 - 2) Trouble Alarm: Low battery.
 - 3) Alarm: Power off.
- E. Acceptable manufacturer: Kantech KT series
 - 1. Contractor will size out the appropriate control panel to accept the number of card readers, programmed doors, and all inputs shown on the drawings.
 - 2. Contractor will coordinate with the Owner on obtaining the proper IP address for the controllers as needed.
 - 3. All access control panels or input output panels, as needed, will be installed on new plywood backboards in the telecom rooms if required.
 - 4. Contractors who place the panel in locations not approved on the contract documents or by written authorization from the consultant will be required to move the panel to the approved location. Such a move will be performed at the contractor's expense.
- F. All access control panels shall have an 8 ½ x 11 laminated layout that has the following information placed inside or adjacent to the panel location. Contractor shall provide a mock- up of this document prior to deploying it inside the control panels.
 - 1. In the upper left corner of the layout provide the name of the installing company, phone number and Texas Security License number
 - 2. In the upper right corner of the page provide the Name of the campus, the MDF or IDF room location.
 - 3. IP Address of the panel will be placed under the MDF / IDF room I.D., provide the subnet mask beneath the IP address.
 - 4. Place the gateway IP address information below the subnet mask
 - 5. Place the service contract information (contact and phone number or just phone number will be acceptable)
 - 6. Beneath the common information provide a line diagram showing each blade location and the name of the device attached to each input on each card.
- G. All wiring shall be neatly dressed to each device input location and labeled within 1" of the termination at the input. Wiring includes all devices and the wiring bringing in the power for the power supply.
- H. Wire all tamper switches on each control panel door back into the system.
- I. Label the battery and power supply location with the name of the campus, the MDF or IDF room location (MDF, IDF A etc) and the date in which the battery was installed. Labels shall consist of white backgrounds with black letters with a large font. Machine generated adhesive labels only. Nothing handwritten shall be acceptable.

2.7 DOOR AND GATE HARDWARE INTERFACE

- A. Exit Device with Alarm: Operation of the exit device shall generate an alarm. Exit device are specified in Section 087100 "Door Hardware."

- B. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."
- C. Door hardware power supplies
 - 1. The hardware system will incorporate a series of electronic locksets and electronic latch retraction devices. The door hardware contractor shall provide and install power supplies to support the specific door hardware from a centralized location if possible. Local power supplies supporting latch retraction door hardware shall be provided by the door contractor.
 - 2. The contractor shall be responsible for sizing the wire gauge to carry the proper amount of power from the power supply to the door and will connect the wiring to the door hardware.
 - 3. Contractor installed cable pathways shall comply with all other cabling pathways.
- D. Request to exit devices
 - 1. RTE devices shall be incorporated into the door hardware exit devices and installed by the door hardware contractor.
 - 2. The access control contractor will wire the RTE from the exit hardware through the door to the EPT transfer hinge and into the controller.
 - 3. Coordinate with the door hardware contractor and electrical contractor prior to installation.
- E. Door Hardware
 - 1. All door hardware shall be provided and installed by the door hardware sub-contractor.
 - 2. Reference the design drawings for all door locations and all functional requirements.
 - 3. The access control contractor shall review the door hardware schedule and compare all device locations on the plans with the schedule and subsequent door details. Report any conflicts to the consultant immediately. The drawings shall take precedence over any door hardware specification discrepancies concerning the function of the door in regards to the access control system.
- F. Door position switches (DPS)
 - 1. Reference drawings for door position switch locations.
 - 2. Use dual technology flush mounted door contacts positioned in the top of each door for all new door locations as indicated on the drawings. Contacts will be used by both access control and intrusion alarm contractors.
 - a. Access control shall wire the door contacts to the controllers.
 - b. Intrusion shall wire the contacts back to the intrusion alarm panels.
 - 3. Use surface mounted door contacts for all roll up door locations and roof hatch locations as needed.
 - 4. The devices will be programmed to show door open, closed and door ajar or held open alarm events. See the programming section for the time delay to be programmed for all hold open alarm events.

2.8 FIELD-PROCESSING SOFTWARE

- A. Operating System:
 - 1. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
 - 2. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
 - 3. Execution of local processor application programs shall utilize the data in memory resident files.

4. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
5. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).

B. Startup Software:

1. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
2. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
3. Initiates operation of self-test diagnostic routines.
4. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
5. If the database and application programs are resident, the local processor shall immediately resume operation.

C. Operating Mode:

1. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
2. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
3. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
4. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
5. Local processors shall accept software downloaded from the central station.
6. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.

- D. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.

E. Functions:

1. Monitoring of inputs.
2. Control of outputs.
3. Reporting of alarms automatically to the central station.
4. Reporting of sensor and output status to central station upon request.
5. Maintenance of real time, automatically updated by the central station at least once a day.
6. Communication with the central station.
7. Execution of local processor resident programs.
8. Diagnostics.
9. Download and upload data to and from the central station.

2.9 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. The Contractor will be responsible for providing all required software client licenses.
- D. The Contractor shall be responsible for performing the following programming:
 - 1. Ensure that all switch ports are properly configured with the owner.
 - 2. Provide MAC address information on all panels being installed to the Owner Representative through the general Contractor prior to installation.
 - 3. Assign all IP addresses to the panels in numerical and sequential order.
 - 4. Coordinate all partitioning requirements with the Owner Representative.
 - 5. Load the electronic floor plans in a format that is compatible with the Owner's system.
 - 6. Program all the new icons showing each device location.
 - 7. Label all doors within the software according to the direction of the Owner Representative.
 - 8. Program alarm events as specified by the Owner Representative including all access levels, events and lock down reporting and messaging.
- E. Emergency panic / lock down button
 - 1. Contractor will provide and install emergency alarm buttons at the designated office areas, refer to technology drawings for locations.
 - 2. The button will be placed in the knee space below the transaction window. Coordinate final location with the Owner prior to installation.
 - 3. When the button is activated, the system shall secure all doors on the campus, including doors that are in a scheduled unlock period.
 - 4. All campus card readers shall be disabled during the lockdown period. The system shall only allow entry to those with a pre-determined clearance filter level. I.E. Knox box cards, SRO personnel or other first responders. The Owner shall program these credentials.
 - 5. Upon activation and reset of the button the system shall send an email and text message to select personnel.

- a. Coordinate with the Owner on exact wording for these messages and for the list of personnel who shall be authorized to receive the messages.
 - b. The message will include the specific name of the campus in which the button was pressed or reset.
 6. The Contractor shall provide two (2) keys with each device and deliver one key to the Owner through the transmittal process. The second key shall be placed in the campus lock box as specified below.
- F. Door release buttons
1. Contractor shall provide and install a new surface mounted hold up button located underneath the receptionist desk that, when depressed, will release the personnel door leading from the office to the secure corridor shown on the drawings. Place the button far enough under the counter so that the button will not be accidentally pressed. Reference the technology drawings for the button and the controlled door locations.
 2. Depressing the button should show in the system, as an approved entry but the log should record it as being released by the receptionist not a specific individuals card.
 3. The access control Contractor will provide and install the release button underneath the receptionist desk. A concealed pathway to the desk from the overhead lay in ceiling will be provided by the electrical Contractor. Coordinate final location with the Owner prior to installation.
- G. Lock down key storage
1. The Contractor shall provide and install a secured lock box for securing one of the two keys used to reset the lock down button.
 2. The box shall be surface mounted to a location selected by the Owner.
- H. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
 3. No hand-written labels are permitted.
- D. At completion, cable and asset management software shall reflect as-built conditions.
- E. Reference submittal closeouts for drawing requirements.

3.4 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 - 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel if needed.

3.6 DEMONSTRATION

- A. The following items shall be reviewed during the demonstration process:
 - 1. All device locations shall match the record drawings.
 - 2. All devices are properly labeled and identified both in the access control system and on the record drawings.
 - 3. All components are functioning and, when tested, report the correct activity in the software management system.
 - 4. Demonstrate the lock down button functions and ensure all credentials and other means of ingressing the building through the access control system are functioning properly.

END OF SECTION

SECTION 281500

ACCESS CONTROL HARDWARE 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. Contractor shall furnish and install additional access control components as indicated on the contract drawings to extend the Owner's existing system to the added and renovated sections of the middle school.
- B. Section Includes:
 - 1. Card readers, credential cards, and keypads
 - 2. Biometric identity-verification equipment
 - 3. Cables
 - 4. Transformers
- C. Related Requirements:
 - 1. Section 281300 "Access Control System Software and Database Management" for control and monitoring applications, workstations, and interfaces.

1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. PC: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.

- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.
- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

- A. Contractor shall provide the following:
 - 1. Manufacturer cut sheets shall include the manufacturer name, model number and description of each listed component.
 - 2. Electronic copies in pdf format
 - 3. If the data sheet includes multiple part numbers or models the bidding Contractor will indicate which particular model is being submitted by marking the appropriate model number with an "X" or an arrow.
- B. Proof of manufacturer certification and a manufacturer-certified technician to execute all required programming and to participate in the system quality control and commissioning process.
- C. Current state license indicating the company is licensed in the State of Texas as a private security integration company.
- D. Shop drawings shall provide the following:
 - 1. Architectural floor plans indicating all system device locations.
 - 2. Full schematic wiring information for all devices. Wiring information shall include cable type, cable length, conductor routings, quantities, and point-to-point termination schedules.
 - 3. Complete access control system one-line block diagram.
 - 4. Statement of the system sequence of operation.
 - 5. Riser diagrams showing interconnections.
 - 6. Detail drawings showing installation and mounting.
 - 7. Fabrication drawings for console arrangements and equipment layout.
- E. Approval of the submittal by the Consultant does not relieve the Contractor of the accuracy required by the contract documents. This includes storage calculations, colors and quantities.
- F. Equipment shall not be ordered and work shall not commence until the submittals have been approved.

1.5 CLOSEOUT SUBMITTALS

- A. All substantial completion and/or final acceptance site inspections shall include the Contractor's as-built drawings. Failure to submit as-built drawings will result in delays to substantial completion and/or final acceptance.
- B. Closeout submittals shall be submitted with the following provisions:
 - 1. Maintenance Data: Include manufacturer's operating instructions, original copies of all software, recommended maintenance required and maintenance intervals.
- C. Provide an Excel spreadsheet containing the following information:
 - 1. Panel Name
 - 2. IP Address (as obtained from the Owner's representative)
 - 3. MAC address of each camera (obtained from the manufacturer)
 - 4. MDF or IDF room where the camera cable originates. This may require coordination with the Division 27 0000 Contractor.
 - 5. Switch port name or location. Coordinate this with the Owner Representative.
- D. Record drawings will provide all final device locations and their assigned nomenclature including the following information:
 - 1. Manufacturer and model number
 - 2. IP address
 - 3. MAC address
 - 4. Update the original submittals of the floor plans. Relocate any device that may have been moved or altered during the life span of the project. Devices shall include all cable pathways, door contacts, motion sensors, access control panels, request to exit devices and other devices associated with the access
- E. Update the line diagram drawings provided during the submittal phase that indicated device locations back to the panel. This will include any changes to the door controllers, DPS, RTE, motion sensors, alarm buttons, and door release buttons.
 - 1. Each device shall be labeled per the direction of the owner representative.
- F. Provide panel elevation details indicating the location and quantity of all panels that were installed as part of this contract.
- G. All door locations shall be numbered to match the current door numbers at the Owner facilities. Do not use the architectural door numbers. Coordinate with the Owner Representative on door number locations
- H. Title blocks used on all drawings will be that of the Contractor and shall include the following:
 - 1. Company name
 - 2. Company address
 - 3. Company phone number for service
 - 4. Date on the drawings will match the date of final acceptance for warranty purposes.
- I. Contractor will provide (1) electronic copy of the record drawings on a USB flash drive.
 - 1. Electronic copies of the drawings will be in black and white only.
 - 2. Drawings will be issued in both .DWG and .PDF formats.
 - 3. The drawings shall accurately reflect all changes and additions to the surveillance system since the bid.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Contractor
 - 1. The Contractor, as a business entity, shall be an authorized, certified representative/dealer of the specified system for a period of three (3) years.
 - 2. The Contractor must have previously established offices located within 120 miles of the project location.
 - 3. The Contractor shall be capable of responding to a service call within four (4) hours.
 - 4. The Contractor shall be capable of initiating proposed services by dispatching technicians to repair a system within one (1) calendar / business day of a service request.
 - 5. The Contractor shall not have any grievances, license violations or complaints of record regarding workmanship, code compliance, or service response.
 - 6. The Contractor shall have a minimum of five (5) years of experience with the installation and project management of similar sized solutions.
- C. All programmers assigned to this project must have a minimum of (3) years of programming experience with the proposed solution and a current training certificate.
- D. Sub-Contractors
 - 1. The use of subcontractors must be approved by the Owner in writing.
 - 2. All subcontractors shall meet the same licensing, certification and experience requirements of the specified system.
- E. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
- B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
- C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
- D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.8 PROJECT CONDITIONS

- A. The Contractor shall perform the work in accordance with the contract documents and field conditions prior to work.
- B. The Owner makes no representations as to the accuracy or completeness of the site information furnished to the Contractor and does not expressly or impliedly warrant same and is not responsible for any interpretations or conclusions reached by the Contractor with respect thereto. It is Contractor's sole responsibility to verify, to its own satisfaction, all site information.

- C. Project Environmental Requirements
 - 1. Do not begin installation until instructed to perform by the Owner Representative.
 - 2. While on any property owned by the Owner, all Contractors shall comply with Owner policies concerning alcohol, tobacco, electronic cigarettes, open-carry and/or concealed firearms as well as Owner policy governing dress, behavior etc.

PART 2 - PRODUCTS

2.1 OPERATION

- A. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

- A. Card readers
 - 1. Acceptable manufacturer: Kantech
 - 2. IoProx multipurpose readers
 - 3. Card readers shall fit a single gang back box for mounting to walls or other exterior surfaces.
 - 4. The electrical contractor shall provide and install the conduit and single gang back box pathways at each reader location.
 - 5. The security contractor shall seal all exterior mounted reader locations with a clear UV resistant sealant to prevent insect or water damage.
- B. Credentials
 - 1. Kantech ioProx clamshell credentials with pre-punched hole for lanyard support.
 - 2. Qty: 300
 - 3. Fac code:
 - 4. Sequence number:

2.4 PUSH-BUTTON SWITCHES

- A. Door release buttons
 - 1. Acceptable manufacturers:
 - 2. United Security, HUB series with momentary operation and screw terminal configuration
- B. Emergency lockdown buttons
 - 1. Acceptable manufacturers:
 - 2. Amseco HUSCK20 hold up button w/ two reset keys.
- C. Emergency lockdown button key storage
 - 1. Acceptable manufacturer: Grainger

2. KIDDE Model 1015 or approved alternate.

2.5 CABLES

- A. General Cable Requirements: Comply with requirements in Section 270513 "Conductors and Cables for Communications Systems" and as recommended by system manufacturer for integration requirement.
- B. TIA 232-F communications require three conductors with an overall shield and a distance limitation of 50 ft. (15 m).
- C. The Contractor will provide any additional cabling that may be needed to provide additional power (above the 802.3 PoE requirements) for panels, door power supplies, etc.
- D. The Contractor shall be responsible for providing and installing any additional wiring needed for connecting door position switches, surface mounted request to exit devices, strikes, latch retraction devices, motion detection devices and any other devices required for the functionality of the system to the controller.
- E. All cables will be rated for the environment in which they are installed.
- F. Cabling for all approved manufacturer's hardware must meet factory specifications, including the requirements for cable that is stranded, twisted, with an overall shield to eliminate electrical interference.
- G. Pair counts and wire gauge must meet the approved manufacturer's specifications based upon wiring distances.
 1. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.6 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

3.4 CABLE APPLICATION

- A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. between terminations.
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
- E. Card Readers and Keypads:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft..
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

3.5 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Bond shields and drain conductors to ground at only one point in each circuit.
- D. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

- A. Install card readers, door release push buttons and panic emergency lock down buttons.

3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
 - 3. No hand written labels are acceptable.
- D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.
 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
 3. Security personnel.
 4. Hardware maintenance personnel.
 5. Corporate management.

END OF SECTION

SECTION 28 2000
VIDEO SURVEILLANCE

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. The Contractor shall furnish and install video surveillance cameras as indicated on contract drawings, include surveillance cameras, camera mounts, licensing and programming compatible with the Owner's video management system and storage solutions utilizing the Owner's Local Area Network (LAN) and Wide Area Network (WAN) for all required network connectivity. Data network electronics, capable of providing the required Power over Ethernet (PoE) shall be provided by others. Cameras shall be added to the Owner's existing surveillance system.
- B. Communications cabling for each camera location shall be provided by others. Additional cabling required for the successful operation of the exterior cameras shall be the responsibility of the surveillance Contractor.
- C. Contractor shall refer to the technology drawings for all device locations.

1.3 DEFINITIONS

- A. AGC: Automatic gain control.
- B. B/W: Black and white.
- C. CCD: Charge-coupled device.
- D. FTP: File transfer protocol.
- E. IP: Internet protocol.
- F. LAN: Local area network.
- G. MPEG: Moving picture experts group.
- H. NTSC: National Television System Committee.
- I. PC: Personal computer.
- J. PTZ: Pan-tilt-zoom.
- K. RAID: Redundant array of independent disks.

- L. TCP: Transmission control protocol - connects hosts on the Internet.
- M. UPS: Uninterruptible power supply.
- N. WAN: Wide area network.

1.4 ACTION SUBMITTALS

- A. Contractor shall provide the following with the submittal package:
 - 1. Manufacturer product data sheets shall include the manufacturer name, model number and description of each listed component.
 - 2. Electronic copies in pdf format
 - 3. If the data sheet includes multiple part numbers or models the bidding Contractor will indicate which particular model is being submitted by marking the appropriate model number with an "X" or an arrow.
 - 4. Proof of manufacturer certification and a manufacturer-certified technician to execute all required programming and to participate in the system quality control and commissioning process.
- B. Current state license indicating the company is licensed in the State of Texas as a private security integration company.
- C. Approval of the submittal by the Consultant does not relieve the Contractor of the accuracy required by the contract documents. This includes storage calculations, colors and quantities.
- D. Equipment shall not be ordered and work shall not commence until the submittals have been approved.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to the manuals please include the following items:
 - 1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.
 - 2. As-built drawings
 - a. All substantial completion and/or final acceptance site inspections shall include the Contractor's as-built drawings. Failure to submit as-built drawings will result in delays to substantial completion and/or final acceptance. As built drawings shall provide the following:
 - 1) Device locations
 - 2) Camera names as approved by the owner.
 - 3) Title blocks used on all drawings will be that of the Contractor and shall include the following:
 - a) Company name
 - b) Company address
 - c) Company phone number for service
 - d) Date on the drawings will match the date of final acceptance for warranty purposes.
- B. Provide an Excel spreadsheet containing the following information:

1. Facility Name
 2. Camera Name (as coordinated with the Owner's representative)
 3. Camera Manufacturer and Model
 4. IP Address (as obtained from the Owner's representative)
 5. MAC address of each camera (obtained from the manufacturer)
 6. Camera Installation Date
 7. MDF or IDF room where the camera cable originates. This may require coordination with the Division 27 0000 Contractor.
 8. Switch port name or location. Coordinate this with the Owner Representative.
 9. Record drawings will provide all final camera locations, field of view, and their assigned nomenclature including the following information:
 10. Manufacturer and model number
 11. Camera name determined through coordination with the Owner Representative
 12. IP address
 13. MAC address
- C. Contractor will provide (1) electronic copy of the record drawings on a USB flash drive.
1. Electronic copies of the drawings will be in black and white only.
 2. Drawings will be issued in both .DWG and .PDF formats.
 3. The drawings shall accurately reflect all changes and additions to the surveillance system since the bid.

1.6 PROJECT CONDITIONS

- A. The Contractor shall perform the work in accordance with the contract documents and field conditions prior to work.
- B. The Owner makes no representations as to the accuracy or completeness of the site information furnished to the Contractor and does not expressly or impliedly warrant same and is not responsible for any interpretations or conclusions reached by the Contractor with respect thereto. It is Contractor's sole responsibility to verify, to its own satisfaction, all site information.
- C. Project Environmental Requirements
1. Do not begin installation until instructed to perform by the Owner Representative.
 2. While on any property owned by the Owner, all Contractors shall comply with Owner policies concerning alcohol, tobacco, electronic cigarettes, open-carry and/or concealed firearms as well as Owner policy governing dress, behavior etc.
 3. Owner approved badges, if required, will be displayed at all times while on site. Personnel found without their badges on them or who refuse to display them properly will be removed from the job site immediately.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
1. Verify available warranties and warranty periods for units and components with manufacturers listed in Part 2 articles.
 2. Warranty Period: Three years from date of Substantial Completion. Warranty service shall be on a 24-hour/day, 365-day/year basis with a response time not to exceed four (4) hours.

The respondent shall certify that its proposed service facility shall initiate, within 1 business day, on-site repair to any critical system / product that fails while under warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.2 STANDARD CAMERAS

- A. Acceptable manufacturer: American Dynamics Illustra Flex 3MP mini-dome, 2.8-12mm motorized adjustable lenses, indoor and outdoor cameras with vandal resistant housings, clear domes white housings. Supports H.265 video compression.
- B. Outdoor Camera: Illustra Pro IFS03D1OCWTT
- C. Indoor Camera: Illustra Pro IFS03D1ICWIT

2.3 CAMERA-SUPPORTING EQUIPMENT

- A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
- B. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
- C. Protective Housings for Fixed and Movable Cameras: Match all enclosures with camera mounting and connecting provisions.
 - 1. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
 - 2. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
 - 3. Sun shield shall not interfere with normal airflow around the housing.
 - 4. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
 - 5. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
 - 6. Enclosure Rating: IP67 for outdoor cameras with Vandal resistant IK10 ratings.

2.4 VMS, STORAGE AND PROGRAMMING REQUIREMENTS

- A. Existing VMS Manufacturer: ONSSI
- B. The surveillance contractor will be responsible for providing all required licenses for each camera being added to the system.
- C. The current storage system is storing files for 28 days of continuous use.
 - 1. Contractor shall provide and install additional storage for the existing server in the MDF room.
 - a. Coordinate with the Owner for all camera settings to ensure 28 days of storage are being met.
 - b. The Owner shall provide the operating system software (VMS)
- D. The contractor will be responsible for performing the following programming
 - 1. The contractor will load the electronic floor plans of the facilities onto the system; program all the new icons showing each camera location.
 - 2. Set all camera views and angles with the Owner. Label all new cameras according to the direction of both afore mentioned parties. Perform this coordination prior to the start of installation.
 - 3. Coordinate drop locations for the cameras with the Owner to ensure all ports on the District switches are properly configured. Provide MAC address information on all new cameras being installed.
 - 4. Map navigation with active camera previews
 - a. Mapping navigation will start at a district wide map, add the middle school campus to the existing map showing all Owner's facility's that have cameras installed.
 - b. Step 2 of map navigation will be the facility complete sight map to include all buildings located on site that have cameras.
 - c. Step 3 of map navigation will be a complete as-built of the selected building to include all camera icons to coincide with actual install.
 - d. Step 4 of map navigation will be the selected active camera previews
 - 5. Integration with access control system.
 - a. Link all cameras at main entrances to events in access control software on alarm conditions
 - b. Link all cameras with motion detector events as determined by the Owner. Cameras will be linked to the nearest motion detector.
 - 6. Automated push-video alerting
 - a. The system shall be capable of supporting push-video alerting to owner furnished iPads. No additional programming will be required by the contractor.
 - 7. Customized Views
 - a. These views shall be established by the Owner and will not be the responsibility of the Contractor.
- E. All camera and software licenses and accompanying software will be transferred to the Owner if applicable.
- F. Contractor will include all necessary licensing fees for one year of maintenance coverage for each camera in the project. The year will begin at the owners approved substantial completion date and not at the date of purchase by the integrator.
- G. At no time will the Contractor discuss any setup, programming or coordination with any staff member without approval from the Owner main point of contact. All questions and coordination requests will be routed through the architect in writing until such a time that the Owner deems necessary.

2.5 WARRANTY SOFTWARE MAINTENANCE AGREEMENT

- A. The owner currently has a five-year software maintenance agreement in place on the servers. Contractor shall include any additional licensing costs for adding the new cameras into the existing maintenance agreement with the bid.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

- A. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: All premise distribution cabling shall be installed by the Div. 27 0000 contractor. Patch cables shall be delivered to the owner for connecting the cameras to the installed data network connections. Obtain patch cables from owner for final installation.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras and infrared illuminators level and plumb.
- B. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
- C. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
- D. Contractor shall coordinate with the Owner Representative on final placement of cameras prior to any final rough in.
 - 1. Failure to coordinate with the Owner Representative may result in relocation of the camera at the Contractor's expense.
- E. Cameras shall be placed according to the drawings and where field of view objectives can be met. The Contractor will notify the Owner Representative if the proposed location is obstructed and shall recommend an alternate location.
- F. Cameras shall be positioned to avoid direct light sources/fixtures and extreme backlit situations. Cameras shall be oriented or adjusted as required or directed by the Owner.

- G. Identification markings and systems shall be machine generated. Hand written labels will not be accepted.
- H. Conduit sleeves and pathways are required to support cameras. Plastic bushings shall be installed at each end of any conduit.
 - 1. Wiring installed in any penetration without a proper sleeve shall be removed and replaced at the Contractor's expense.
- I. The Contractor shall apply sealant around all exterior camera mounts. This includes cameras located under roofs or canopies.
- J. Contractor shall be responsible for supporting patch cables with dedicated J-hooks installed adjacent to the camera locations. Contractor shall not allow the cables to touch or rest on the ceiling tiles, conduits, pipes, insulation, HVAC ductwork or other trade pathways. All j-hooks shall be properly secured to the building structure, dedicated all thread or dedicated grid wire. Grid wire dedicated to supporting the ceiling shall not be used.
 - 1. Contractor shall not use plastic tie wraps on the patch cables at any time. Patch cables found with plastic tie wraps on them shall be replaced completely at the Contractor's expense.
 - 2. The Contractor shall fire stop all penetrations to maintain the rating of the barrier in which the penetration is located.
- K. Interior Ceiling Mount
 - 1. Ceiling mounted interior cameras shall not be supported directly on the ceiling tile and shall have a T-bar or other type system that will keep the camera weight supported on the grid and not the tile.
 - 2. In addition to grid supported mounts, all new ceiling cameras shall be supported with additional security wire that will prevent the camera from falling down should the ceiling grid be removed. This wire can be attached to the camera directly only by following the manufacturer's recommendations. Support wire shall not be supported by any cable pathway, ceiling grid wire or sprinkler system.
 - 3. New ceiling mounted cameras at all other locations will be trimmed out with (color name) mounts and trim kits.
- L. Interior Wall Mount
 - 1. Cameras (if applicable) shall be mounted directly on the provided back box.
- M. Exterior Mount
 - 1. Anchors used to mount the cameras shall be suitable for the surface in which they are installed. Plastic anchors shall not be used to support the cameras.
- N. The surveillance Contractor will be responsible for providing all required licenses for each camera being added to the system.
- O. The storage system shall require 30 days of continuous storage for all cameras with the exception of the special education classrooms.
- P. Contractor will set the new cameras at the following settings:
 - 1. Interior cameras – record motion only, assume 10 FPS, 1920 X 1080 with H.264 compression, set bit rate to constant. Field Cameras will assume 10 FPS, 3840 X 2160.
 - 2. Exterior cameras – record full time during normal operating hours from 6:00 AM to 7:00 PM, Monday-Friday at 10 FPS, 1920 X 1080. Set bit rate to constant.
 - 3. Assume 40% motion on the interior cameras from 6:00 AM-7:00PM Monday through Friday and 20% for all day Saturday and Sunday.
 - 4. Set pre/post alarm event recording to 30 seconds.

- Q. The Contractor shall be responsible for performing the following programming:
1. Ensure that all switch ports are properly configured.
 2. Provide MAC address information on all new cameras being installed to the Owner Representative through the general Contractor prior to installation.
 3. Assign all IP addresses to the cameras in numerical and sequential order.
 4. Coordinate all partitioning requirements with the Owner Representative.
 5. Load the electronic floor plans in a format that is compatible with the Owner's system.
 6. Program all the new icons showing each camera location.
 7. Set all camera views and angles with the Owner Representative.
 8. Label all new cameras within the VMS according to the direction of the Owner Representative.
 9. Program alarm events as specified by the Owner Representative.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Prepare equipment list described in "Informational Submittals" Article.
 - b. Verify operation of auto-iris lenses.
 - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - e. Set and name all preset positions; consult Owner's personnel.
 - f. Set sensitivity of motion detection.
 - g. Connect and verify responses to alarms.
 - h. Verify operation of control-station equipment.
 3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

- 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. Video surveillance system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within six (6) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one (1) visit to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
 - 1. Check cable connections.
 - 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 - 3. Adjust all preset positions; consult Owner's personnel.
 - 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 - 5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION

SECTION 28 3100

INTRUSION DETECTION

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. Contractor shall furnish and install additional intrusion detection system components as indicated on the contract drawings to extend the Owner's existing system to the added and renovated sections of the middle school.
- B. Section Includes:
 - 1. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
 - 2. Integration of other electronic and electrical systems and equipment.
- C. Related Sections:
 - 1. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
 - 2. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
 - 3. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
 - 4. Section 271523 "Communications Optical Fiber Horizontal Cabling" for multi- and single-mode horizontal (general use, riser-, and plenum-rated) optical fiber.
 - 5. Section 270513 "Conductors and Cables for Communications Systems" for power cabling between master control units and field-mounted devices and control units.
 - 6. Section 281300 "Access Control System Software and Database Management" for applications, interfaces, and workstations.
 - 7. Section 283121 "Perimeter Security Systems" for outdoor intrusion detection devices, including lighting and communications associated with chain-link fence gates.
 - 8. Section 282000 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.3 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. PIR: Passive infrared.
- C. RFI: Radio-frequency interference.
- D. UPS: Uninterruptible power supply.

- E. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
- H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
- I. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing].
- J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

- A. Product Data: Components for sensing, detecting, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
 - 1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections.
 - a. Indicate methods used to achieve systems integration.
 - b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
 - c. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
 - 2. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside the building.
 - 3. Master Control-Unit Console Layout: Show required artwork and device identification.
 - 4. Device Address List: Coordinate with final system programming.
 - 5. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
 - 6. Details of surge-protection devices and their installation.

7. Sensor detection patterns and adjustment ranges.

- C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Data for each type of product, including features and operating sequences, both automatic and manual.
 2. Master control-unit hardware and software data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
 2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 3. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 4. Installation Supervision: Installation shall be under the direct supervision of a Level 2 Commercial Installer, who shall be present at all times when work of this Section is performed at Project site.
 5. Testing Supervisor: Currently certified as a Technician to supervise on-site testing.
- B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
1. At least one of whom is a Certified Systems Integrator.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three (3) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Description: Hard-wired modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.
- B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
 - 1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
 - 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
 - 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.
- D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- E. Operator Commands:
 - 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 - 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 - 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 - 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
 - 5. Protected Zone Test: Initiate operational test of a specific protected zone.
 - 6. System Test: Initiate system-wide operational test.
 - 7. Print reports.
- F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- G. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
- H. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- I. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both

protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

- J. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
- K. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
- C. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.
- D. Comply with NFPA 70.
- E. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
 - 1. Door hardware specified in Section 087100 "Door Hardware."
 - 2. Door hardware specified in Section 087111 "Door Hardware (Descriptive Specification)."
 - 3. Elevators specified in Section 142100 "Electric Traction Elevators."
 - 4. Elevators specified in Section 142400 "Hydraulic Elevators."
- F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
 - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- G. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- H. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- I. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or

disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

- J. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- K. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.
- L. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.
- M. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

- A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
- B. Interior Electronics: NEMA 250, Type 12.
- C. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

- A. Keypad is existing near the main office of the middle school.
- B. Reference the technology plans for existing keypad locations. Back box and conduit pathways to all keypads are by others.

2.5 DOOR AND WINDOW SWITCHES

- A. Flush-Mounted Dual Input Switches for door contacts: Shall be installed by the access control contractor.
- B. No window switches are required.

2.6 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

- A. All devices must not allow anyone to walk underneath the device undetected.
- B. Acceptable manufacturer is Bosch Ds938Z for all 360-degree motion locations.
- C. All other long range motion locations will be ceiling or wall mounted motion sensors by Bosch Blue Line Gen2 PIR Motion Detectors PN# ISC-BPR2-W12.

- D. Ceiling mount locations shall use the Bosch B338 ceiling mount bracket as needed.
- E. Wall mounted locations may use either the Gimbal Mount or swivel mount based on the device location.
- F. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.

2.7 MASTER CONTROL UNIT

- A. Acceptable Manufacturer: Interlogix Networkx
 - 1. Contractor shall size the panel to support the number of devices shown on the drawings.
 - 2. Each device shall be considered its own zone.
 - 3. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - 4. Include a real-time clock for time annotation of events on the event recorder and printer.
 - 5. Addressable initiation devices that communicate device identity and status.
 - 6. Control circuits for operation of mechanical equipment in response to an alarm.
 - 7. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
 - a. Acknowledge alarm.
 - b. Silence alarm.
 - c. System reset.
 - d. LED test.
- B. Partitions
 - 1. The building will be partitioned into two sections.
 - a. Kitchen area only (controlled only by the kitchen keypad)
 - b. Main building (controlled only by the keypad in the main vestibule)
- C. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
- D. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.
- E. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
- F. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands

initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.8 AUDIBLE AND VISUAL ALARM DEVICES

- A. Acceptable manufacturer: Interlogix MPI-36
- B. Siren/Speaker, Surface Mount, 2-Channel (Yelp/Steady) Siren/Speaker in MPI-35 Housing. 6~13.8VDC, 350mA Current Draw. Up to 106DB Output. UL Listed, White
- C. Reference drawings for siren locations

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
- D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - 1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
 - 2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
- E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

- A. Integrate intrusion detection system with the following systems and equipment:
 - 1. Electronic door hardware.
 - 2. Elevators.
 - 3. Intercommunications and program systems.

3.3 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.

- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

3.4 WIRING INSTALLATION

- A. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Wires and Cables:
 - 1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
 - 2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
 - 3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 270513 "Conductors and Cables for Communications Systems."
 - 4. Data and Television Signal Transmission Cables: Install according to Section 270513 "Conductors and Cables for Communications Systems"
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
- F. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 270553 "Identification for Communications Systems."

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 270553 "Identification for Communications Systems."
- B. Install instructions frame in a location visible from master control unit.
- C. No handwritten labels are permitted inside the enclosure.

3.6 GROUNDING

- A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

- B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
- D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 270526 "Grounding and Bonding for Communications Systems."

3.7 FIELD QUALITY CONTROL

- A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - 1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- E. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
 - 1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - 2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
- F. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."
- G. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.]

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION

SECTION 28 46 21

FIRE DETECTION AND ALARM SYSTEM EXPANSION

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. Revise and expand the existing Gamewell FCI E3 fire alarm system, the panel is located in the main electrical room and the wall and ceiling mount speaker strobe signals are System Sensor SpectrAlert Advance series with red housings imprinted "FIRE". The expanded system shall serve the additional areas as indicated on the project plans to provide a complete and operating system. Only the new devices to be installed in this projects scope of work are indicated on the plans. At the fire alarm Contractors' discretion and expense, the existing Signaling Line Circuits (SLC), Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC) may be rearranged or reconfigured. Match new devices to existing.
- B. The existing previously approved fire alarm system shall be revised and expanded in accordance with the 2012 International Building Codes and local amendments. Being that this expansion of this fire alarm system will constitute a Level 2 Alteration (The Level 3 Alteration Classification applies where the work area exceeds 50 percent of the building area per the International Existing Building Code Item 505.1 Alterations – Level 3, Scope.). The reconfiguration and extension of the existing previously approved fire alarm system shall be done in accordance with Exception 1 to the International Existing Building Code Item 804.4 Fire alarm and detection, 804.4.1 Occupancy. This is also stated in the International Fire Code in the Exception to Item 1103.7 Fire alarm systems.

1.2 WORK INCLUDES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.
- B. Furnish and install all equipment, accessories, and materials in accordance with the project specifications and drawings to provide a complete and operating system.
- C. Equipment specified herein is designed to provide specific functional and operational characteristics. It is the responsibility of the fire alarm contractor to provide all features and functions as outlined in these specifications.
- D. It shall be the responsibility of the fire alarm contractor to obtain all required approvals, permits, and certifications from authorities having jurisdiction.
- E. It shall be the responsibility of the electrical contractor to provide and install all conduit systems, standard electrical boxes, and operating power for the fire alarm system as outlined on the project drawings and as required. The fire alarm contractor shall coordinate all requirements with, and provide special back boxes to, the electrical contractor prior to installation of conduit.
- F. NOTE: IN ALL OPEN CEILING AREAS, ALL FIRE ALARM CABLING SHALL BE ENCLOSED IN CONDUIT. It shall be the responsibility of the electrical contractor to provide and install all conduit systems, standard electrical boxes, and operating power for the fire alarm system as outlined on the project drawings and as required. The fire alarm contractor shall coordinate all requirements with, and provide special back boxes to, the electrical contractor prior to installation of conduit.

- G. The electrical contractor shall provide 120-volt power as required to the fire alarm system control unit through individual dedicated branch circuits maximum 20 amperes each. The branch circuit shall not be supplied through ground-fault circuit interrupters or arc-fault circuit interrupters. The fire alarm control panel (FACP), digital communicator (DC), and the signal power expanders (SPX) combine to form the fire alarm control unit. The FACP, DC, and a SPX, or two or more SPXs, et cetera, may be fed from one circuit as long the amperage drawn is within the limitations of a 20-ampere circuit. Each such circuit breaker shall be labeled in red, in a visible area utilizing a self-laminating, flexible vinyl film, non-smear, machine printed label, at the power distribution panel as FIRE ALARM. A breaker panel key shall be stored within the locked cabinet of each fire alarm control unit. The location of all circuit breakers serving the fire alarm control unit shall be posted in the fire alarm control unit cabinets. Each cabinet shall be grounded securely to the building grounding system.
- H. Fire safety control functions include any function that is designed to make the building occupants safer from the impact of fire and smoke during evacuation. These may include fire door hold open/release, coiling fire door release, air handler shutdown, smoke damper or fire/smoke damper control, high volume low speed (HVLS) fan shut down, elevator recall, and automatic door unlocking, including the opening of motorized security grills on alarm. For each controlled device, the contractor providing the device shall wire it internally for fail-safe shut-down and provide a labeled 3' coil of cable outside the unit to allow the fire alarm contractor to make final connection to the controlling relay. Each Fire Safety Control Function circuit controlled device shall be configured such that when the fire alarm system safety control circuit is re-energized, by the fire alarm control panel, the device shall return to normal operation (e.g. re-start or be ready to re-start) without a need for manual or environmental control system intervention. Line voltage, 120 VAC fire safety control function circuits shall be wired by the Electrical Contractor and shall be standard non-supervised line voltage circuits in conduit, utilizing the type of conductors specified in Division 26 for light and power circuits.
- I. Provide all testing, documentation, training, and warranty service contract as outlined in these specifications.

1.3 RELATED SECTIONS

- A. Section 26 05 34 - Provisions For Communication, Security & Safety Systems.
- B. Section 28 05 00 - General Fire Alarm System Requirements.

1.4 DEFINITIONS

- A. Acoustically Distinguishable Space (ADS) – an area distinguished, enclosed, or physically defined from other spaces due to acoustical, environmental, or use characteristics, such as reverberation time and ambient sound pressure level. A basic area of a building or a single room identified for individual measuring of intelligibility.
- B. Common Intelligibility Scale (CIS) – a system created to map all quantitative intelligibility measurement methods to the same scale so that all different results can be compared.
- C. Distortion – any unwanted sounds produced by a sound reinforcement system, which are an alteration, addition, or deviation from the program source and are primarily caused by amplifiers and speakers when the system gain structure is not maximized, the components are damaged, or operating above their design limits. Distortion will diminish the clarity of speech / message / music.
- D. Maximized Gain Structure – the set-up of a sound reinforcement system in which the various components in the audio chain, which may include program sources, microphones, a mixer/pre-amplifier, a power amplifier, an output isolation transformer, and speaker input

isolation transformer taps, have their level adjusted to provide maximum headroom and reduce the potential for poor performance and system clipping. This is accomplished by aligning the gain of each device so that the noise floor of the entire system is at its absolute minimum, each device provides a good S/R, and each component would, if overloaded, clip at approximately the same system output level.

- E. Reverberation - the persistence of sound in a particular enclosed space after the original sound is produced resulting in a number of echoes from the walls, ceilings, hard surfaces, etc. that builds up and then slowly decays as time passes and the sound is absorbed by environment. Reverberation time is the time required, in seconds, for the average sound in a particular room to decrease by 60 decibels after a source stops generating sound. Speech is best understood where sound dies out quickly which may be referred to as an acoustically "dead" environment, as opposed to a "live" environment with a strong echo.
- F. Signal-to-Noise Ratio (S/N or SNR) – in an individual audio component or overall system performance, is a ratio usually measured in decibels (dB) of program output to background noise. The larger the ratio, the more that desirable sounds (music, voice, effects) are separated from acoustical effects and background noise. As a measure of overall audio system performance, the Signal-to-Noise Ratio will encompass all audio distortion and defects, including those caused by digital and analog processing, speaker inaccuracy, signal loss and degradation, ambient noise, room acoustics, etc. at the listeners' location.
- G. Sound Pressure Level (SPL) - a logarithmic ratio scale used to measure the effective sound pressure, or relative loudness, of a sound. SPL is measured in decibels (dB) above a standard reference value of 20 μ Pa sound pressure in air at 1 kHz, which is equal to 0 dB, which is considered the threshold of human hearing. A 10 dB increase in SPL represents a doubling in volume.
- H. Speech Transmission Index (STI) - A scale and quantitative methodology for measuring the intelligibility of a communication system using a test signal audible program of wide band modulating frequency tones, which encompass a combination of vowels and syllables simulating common speech. While the test signal is being played through the communication system, the test instrument computes the signal to noise ratio based on the impact of background noise, reverberation, and distortion. During the test runtime, a value is calculated and the result displayed on the test instrument screen, which will be between zero and one on the STI scale, representing the weighted average estimate of system intelligibility at that location.
- I. Voice Intelligibility or Speech Intelligibility - The quality or condition of being intelligible, capable of being understood; comprehensible; clear, precise, and audible. Voice intelligibility test results for an emergency communication system are considered acceptable if at least 90% of the measurement locations within each ADS have a measured STI of not less than 0.45 (CIS of not less than 0.65), and an average STI of not less than 0.50 (an average CIS of not less than 0.70).

1.5 CODES AND REGULATIONS

- A. Perform all work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are exceeded by the contract documents.
- B. The equipment, materials, and installation shall conform to the latest version of all applicable codes, standards and regulations of authorities having jurisdiction including the following:
 - 1. NFPA 70, National Electrical Code, Articles 250, 300, 725, 760, and 800.
 - 2. NFPA 72, National Fire Alarm and Signaling Code.
 - 3. NFPA 90A, Installation of Air Conditioning and Ventilation Systems.
 - 4. NFPA 101, Code for Safety to Life from Fire in Buildings and Structures.

5. IEC 60268-16:2011(E) Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index.
6. ISO 7240-24:2010 Fire detection and fire alarm systems - Part 24: Sound-system loudspeakers.
7. ANSI 117.1 American National Standard for Accessible and Useable Buildings and Facilities.
8. ASME A17.1 Safety Code for Elevators and Escalators
9. Americans with Disabilities Act.
10. Texas Accessibility Standards (TAS).
11. Texas Insurance Code Chapter 6002 Fire Detection and Alarm Device Installation and 28 TAC §§ 34.600 The Fire Alarm Rules.
12. International Building Codes (IBC).
13. Local and State Building Codes.
14. All requirements of the local Authority Having Jurisdiction (AHJ).

1.6 SUBMITTALS

- A. Submittal procedures: See Section 28 05 00.
- B. Submit a complete submittal package within 30 calendar days after award of this work for approval. Equipment is not to be ordered without approval. Partial submittals are not acceptable for review. Each submittal shall include a dated transmittal.
- C. Submittal may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- D. Quality Assurance Submittal:
 1. Letter from the fire alarm control panel manufacturer stating that the contractor is a factory trained for the proposed system and Factory Authorized Distributor for the area where the project is located.
 2. Current copy of the contractors Fire Alarm Certificate of Registration for sales, service, and installation of fire alarm and fire detection systems issued by the State Fire Marshal.
 3. Copy of the commercial (non-residential) Fire Alarm System Planning Superintendent's License responsible for the design of the system submitted.
 4. Copy of the Fire Alarm Technician's License who will supervise this installation.
 5. Calculations for indicating device circuit current drop and battery backup calculations for each unit.
- E. Product Data Submittal including special boxes, cable, and other material as requested by the Architect including:
 1. A cover sheet with the name and location of the project, the name, address, and telephone number of the Contractor, and the name, address, and telephone number of the submitting sub-contractor. Include on or after the cover sheet sufficient space for review stamps.
 2. An indication of any deviations from Contract Document requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
 3. A product data index and complete equipment list including for each product submitted for approval the manufactures name and part number, including options and selections.
 4. Cut-sheets or catalog data illustrating the physical appearance, size, function, compatibility, standards compliance, and other relevant characteristics of each product on the equipment list. Indicate by prominent notation (an arrow, circle, or other means) on each sheet the exact product and options being submitted.
 5. Submit design data, when the scope of work requires, including calculations, schematics, risers, sequences, or other data.

6. Any resubmittal shall include a complete revised equipment list and any product data that is revised.
- F. Submit shop drawings locating all components of the system, indicating circuit routing, cable type, and gauge. Shop or coordination drawings shall include information that will allow to the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product. Shop or coordination drawings shall be specifically prepared to illustrate the submitted portion of work, this may require diagrams, schedules, details, and accurate to scale equipment and device layouts prepared using a CAD or BIM engineering drawing program.

1.7 QUALIFICATIONS OF A PROPOSED CONTRACTOR

- A. Proposed contractors who do not currently possess the necessary qualifications, trained and experienced personnel, financial capacity, required current licenses, and meet the other requirements herein described will be disqualified.
- B. The contractor shall be licensed by the State of Texas Fire Marshal to sell, install, and service commercial fire alarm systems in accordance with the Texas Insurance Code Chapter 6002.
- C. The proposed contractor, as a business entity, shall be an authorized and designated representative of the fire alarm panel equipment manufacturer, with full warranty privileges, and shall have been actively engaged in the business of selling, installing, and servicing commercial building fire alarm systems for a period of at least 5 years.
- D. Recently formed companies are acceptable only if specific pre-approval is requested, and granted by the Architect/Engineer, based on experience of key personnel, current and completed projects, and all licensing requirements are met 10 working days prior to the contract proposal date.
- E. The proposed Contractor shall have an office within 150-miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owners representatives and the local Fire Marshal in the proper operation of the system, and to provide service throughout the warranty period. The contractor shall be capable of dispatching technicians to repair a system within six hours of a service request.
- F. The proposed contractor shall be fully experienced in the design and installation of the type of Fire Alarm System herein specified, and shall furnish with the contract proposal an itemized list of the installations of the type specified herein. The list shall include the name of the project, date of completion, the amount of the contract, the name, and telephone number of a qualified person to contact for reference. This list must contain at least two (2) projects within a 150-mile radius of this project to allow owners representatives to visit the job sites for review of the system installation and service. Each reference project listed must utilize a fire alarm control panel by the same manufacturer as the proposed system.
- G. The Contractor shall have a full-time employee who is a state licensed Fire Alarm System Planning Superintendent. They shall be responsible for the design of the system submitted and shall sign all submittal drawings.
- H. All work associated with the installation of the fire alarm system shall be under the direct supervision of a state licensed Fire Alarm Technician.
- I. The Contractor shall employ factory-trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the

factory service school within the last 18 months. A certificate of this training shall be provided with the contractors' submittal.

- J. The contractor shall not have any grievances or complaints of record regarding workmanship, code compliance, or service response with either the Owner or the State Fire Marshal. A contractor that has any prior finding(s) of a Fire Alarm License violation or has any litigation of this type in process with the State Fire Marshal is unacceptable.
- K. The ability of a proposed Contractor to obtain plans and provide a performance bond shall not be regarded as the sole qualification of the Contractors' competency and responsibility to meet the requirements and obligations of the contract.
- L. The Builder shall be satisfied that a proposed Contractor meets all the requirements expressed herein before including the Contractor's proposal in the project.
- M. The Owner may investigate, as they deem necessary to determine the ability of the proposed Contractor to perform the work. The proposed Contractor shall furnish to the Owner with any information or data requested for this purpose.
- N. The Owner reserves the right to reject any contract proposal if the evidence submitted, or their investigation, fails to indicate that the Contractor is qualified to fulfill of any part of the contract or to complete the work contemplated therein.
- O. The Owner reserves the right to reject the proposal of any Contractor who has previously failed to perform properly, or complete on time, contracts of a similar nature.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Type: Complete 24 VDC, closed circuit, electrically supervised, analog addressable, intelligent reporting, microprocessor controlled fire detection and alarm system combined with an in-building fire emergency voice alarm communications system (EVAC).
- B. The system shall meet all requirements for a protected premises and supervising station fire alarm system per NFPA 72.
- C. The system and all components shall be tested and found suitable for the specified purpose as part of a protected premises protective signaling (fire alarm) system by a nationally recognized approvals agency acceptable to the AHJ.
- D. All date keeping hardware, firmware, and software provided shall be fully compliant with the calendar year designated in four-digit date format. Any time or date related functions must operate normally, leap year, and daylight savings time must be supported.
- E. The control units, power supplies, batteries, subassemblies, software, firmware, all cable types, detection, notification, control devices, and all accessories required to provide a complete operating system shall be listed and labeled by Underwriters Laboratories, Inc. for fire alarm system use under the latest appropriate testing standard including but not limited to the following:
 - UL 38 Manually Actuated Signaling Boxes for Use with Fire Protective Signaling Systems.
 - UL 50 Enclosures for Electrical Equipment.
 - UL 193 Alarm Valves for Fire-Protection Service
 - UL 217 Single and Multiple Station Smoke Detectors.

UL 228	Door Closers-Holders, With or Without Integral Smoke Detectors.
UL 268	Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	Smoke Detectors for Duct Application.
UL 346	Waterflow Indicators for Fire Protective Signaling Systems.
UL 444	Communications Cables.
UL 464	Audible Signal Appliances.
UL 497B	Protectors for Data Communications and Fire Alarm Circuits.
UL 521	Heat Detectors for Fire Protective Signaling Systems.
UL 539	Single and Multiple Station Heat Detectors.
UL 793	Automatically Operated Roof Vents for Smoke and Heat.
UL 864	Control Units for Fire Protective Signaling Systems, Ninth Edition
UL 910	Test for Cable Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air.
UL 1424	Cables for Power-Limited Fire Alarm Circuits.
UL 1479	Fire Tests of Through-Penetration Firestops.
UL 1480	Speakers for Fire Protective Signaling Systems.
UL 1481	Power Supplies for Fire Protective Signaling Systems.
UL 1581	Electrical Wires, Cables, and Flexible Cords.
UL 1635	Digital Alarm Communicator System Units.
UL 1638	Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling.
UL 1711	Amplifiers for Fire Protective Signaling Systems.
UL 1971	Signaling Devices for the Hearing Impaired.
UL 2043	Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
UL 2572	Control and Communication Units for Mass Notification Systems.

- F. Only equipment devices have been shown on the contract drawings. Specific wiring between equipment has not been shown.
- G. All equipment and components shall be installed in strict compliance with manufacturers' recommendations and the requirements of the components UL listing. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, electrical requirements, cable types, and physical equipment sizes, et cetera, before beginning system installation. Refer to the manufacturers' riser / connection diagrams for all specific system installation / termination / wiring data.
- H. The contractor shall be responsible for sizing, verifying, and supplying proper power supply(s) necessary to operate the system and audible/visual signals.
- I. All equipment and components shall be new and the manufacturer's current model. All like devices shall be of the same manufacturer and model number.
- J. Provide stainless screw/bolt hardware wherever stainless devices are used and in potentially wet areas.
- K. 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 ACCEPTABLE MANUFACTURES

- A. Descriptions and details, acceptable manufacturers' names listed and specific manufacturer and model number items indicated in the plans and specifications shall establish a standard of quality, function, and design. Manufacturers and model numbers listed "no exceptions" shall not be substituted without specific notice in an addendum. Otherwise, where a specific

manufacturer's product is indicated, products of other manufacturers listed as acceptable may be submitted for approval based on the substitute product being, in the opinion of the Engineer, of equivalent or better quality than that of the product specified.

- B. Proposed contractors wishing to propose any product substitution must do so in writing to the specifying authority at least ten (10) days prior to the proposal opening.
- C. For manufacturers equipment or models other than that specified, the proposed contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment. Proposals must include detailed information showing all deviations from the system as specified.
- D. Substitute products for which the proposed contractor does not obtain prior approval will not be considered acceptable for this project. Final approval of alternate products shall be based on the decision of the Owner and Architect. Prior approval to make a proposal for this project does not automatically ensure products will be an acceptable equivalent.
- E. It is the responsibility of the Contractor to provide all features and functions as outlined in these specifications. The functions and features specified are vital to the operation of this facility; therefore, inclusion in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- F. The manufacturers model numbers, functions, and features described in this specification section are those of Gamewell-FCI (Fire Control Instruments) Northford, Connecticut and this shall constitute the quality and performance of the equipment to be furnished. The following are acceptable fire alarm control panel manufactures; any other proposed suppliers must be pre-approved:
- G. The existing system and the manufacturers model numbers, functions, and features described in this specification section are those of the **Gamewell FCI E3** fire alarm system, this shall constitute the quality, compatibility, and performance of the equipment to be furnished, **no exceptions**; any other proposed fire alarm control panel manufactures devices must be pre-approved.

2.3 CIRCUIT TYPES

- A. General: All low voltage fire alarm circuits shall be power limited, electrically or electronically supervised, and of the correct cable type and gauge. Low voltage fire alarm cables of various types are to be permitted within the same raceway or conduit. 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, as per NEC Article 760. T-taps in any electrically supervised circuit are prohibited by this specification. All junction boxes and conduit ends shall be marked red for all low voltage fire alarm circuits.
- B. All fire alarm systems shall be installed in such a manner that the failure of any single alarm-actuating or alarm-indicating device will not interfere with the normal operation of any other such devices.
 - 1. Signaling Line Circuit (SLC): A signaling line circuit is the backbone loop that interconnects all addressable intelligent devices and over which status, input, and output signals are carried. The operation of these circuits is critical to the operation of the system and they shall be wired Class A (Style 6), in a redundant loop with isolation modules. Class A separation of cable routing shall be observed per NFPA 72.
 - 2. Network Node Circuit: The main fire alarm panel and any network node sub-panels or remote annunciators shall use a supervised RS-485 or equivalent interface in network loop over which system status, control, input, and output signals are carried. These circuits shall be wired in a Class A redundant loop, which will be automatically operated

from either end. Separation of outgoing and return cable routing shall be observed per NFPA 72 requirements, including a minimum of four feet separation horizontal and one foot vertical between supply and return circuit conductors.

3. Voice Evacuation Notification Appliance Circuits (Voice NAC): A notification appliance circuit provides operational power to and is directly connected to the speaker signals. These appliances have a relatively large current draw and these circuits shall be of an adequate wire gauge to prevent a voltage drop below the rated operating voltage of the speaker appliances. Circuits may be 25 or 70 VRMS to be determined by the contractor. Shielded cable shall be utilized to minimize electrical noise interference with voice transmission. These circuits shall be wired Class B (Style Y) with electrical supervision and end of line devices.
4. Visual Notification Appliance Circuit (NAC): A notification appliance circuit provides operational power to and is directly connected to the audible and visual signals. These appliances have a relatively large current draw and circuits shall be of an adequate wire gauge to prevent a voltage drop below the rated operating voltage of the appliances. These circuits shall be wired Class B (Style Y) with electrical supervision and end of line devices.
5. Initiating Device Circuits (IDC): Initiating device circuits shall be used only where it is necessary to interface to a contact type or conventional device such as a sprinkler riser waterflow switch, tamper switch, or projected beam detector. Initiating device circuits shall be arranged to serve like categories (beam detectors, heat detectors, tamper switches). Mixed category circuitry shall not be permitted in a single IDC. A two-wire IDC shall contain only devices that require point-contact to operate. A four-wire IDC shall include an additional supervised circuit to supply 24 VDC operating power to devices that require it. These circuits shall be wired Class B (Style B) with electrical supervision and end of line devices, or power supervisory/end of line devices for four-wire circuits.
6. Low voltage, 24 VDC, fire safety control function circuits shall in all cases feature Class D "fail safe" operation and shall not have power backup. These circuits shall be controlled by a fire alarm system activated addressable control relay located within three feet of the device controlled and on activation, or loss of power, the connected device shall actuate to its fire safety condition (i.e. HVAC blower control circuits shall open).
7. Line voltage, 120 VAC, fire safety control function circuits shall in all cases feature Class D "fail safe" operation and shall not have power backup. These circuits shall be controlled by a fire alarm system activated addressable control relay and auxiliary relay pair located within three feet of the device controlled and on activation, or loss of power, the connected devices shall actuate to their fire safety condition (i.e. fire door holders shall release, smoke dampers and fire/smoke dampers shall close). Line voltage fire safety control function circuits shall be wired by the Electrical Contractor and shall be standard non-supervised line voltage circuits in conduit, utilizing the type of conductors specified in Division 26 for light and power circuits.

2.4 FIRE ALARM CONTROL PANEL [FACP]

- A. Revise and expand the existing Gamewell FCI E3 fire alarm system, the panel is located in the main electrical room and the wall and ceiling mount speaker strobe signals are System Sensor SpectrAlert Advance series with red housings imprinted "FIRE".

2.5 FIRE ALARM PLAN AND SYSTEM RECORD DOCUMENT CABINET

- A. Provide adjacent to the fire alarm control panel and adjacent to the fire alarm remote annunciator an updated plan view of all building areas covered by the fire alarm system meeting the following requirements:
 1. Framed and secured to the wall and plan covered with clear acrylic panel, Space Age Electronics Inc. model SSU52003 Display Frame or equivalent.
 2. Size plan to clearly show all required information.
 3. Orient building to place the entry nearest to control panel at the bottom of plan.

4. "YOU ARE HERE" indicator with arrow.
 5. Logical alarm zones.
 6. Room names and numbers. (Verify with Owner)
 7. Show each initiating device with symbol and identification number as programmed in panel.
 8. Do not show indicating (audio/visual) devices.
 9. Symbol legend.
 10. True north arrow.
 11. Scale indicator.
- B. Provide, in accordance with NFPA 72 Chapter 7 Documentation, an adequately sized record documentation cabinet located at the system control unit or at an on premises location approved by the LAHJ and identified at the system control unit. Printed and/or electronic documentation shall include an owner's manual, published instructions, a design narrative and layout, record drawings, site specific software, passwords, and a record of installed software and firmware version numbers. The record documentation cabinet shall be 18-gauge minimum cold rolled steel with a red power coat finish, a stainless steel-piano hinge, and keyed door lock. The cover shall be permanently screened with 1" high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink. The interior shall accommodate as required standard 8.5" x 11" manuals and loose document records, a digital flash drive with USB B connector, a business card holder, and key ring hooks. Shall be a Space Age Electronics, Inc. Part # SSU00689, ACE-11 SRD System Record Documents Cabinet or equivalent.

2.6 STROBE SIGNAL POWER EXPANDERS [SPX]

- A. Provide as required additional power supplies for strobe notification appliance circuits or as a remote power supply.
- B. For all power supplies serving strobe signals, the interface with the main fire alarm control panel shall carry a signal to synchronize the flash timing of all interior strobes in the system in a code 3 pattern at 1 Hz.
- C. Each power supply shall individually report a trouble condition including battery charging failure, battery failure, NAC loss, AC power loss (delay acceptable), power brownout, or ground fault detection.
- D. A trouble condition on an external power supply shall not interfere with normal operation the rest of the system.
- E. In the event of a trouble condition, each power supply shall provide location annotated individual point supervisory incident reporting to the main fire alarm control panel. This may be accomplished using one addressable module per power supply or via power supplies with multiplexed system bus communication or an integrated addressable interface.
- F. The signal power expander supply/charger and batteries shall supply power limited 24 VDC operating and emergency power. The charger shall be capable of maintaining batteries in a fully charged state without damage and of bringing batteries from a fully discharged to a fully charged state within 48 hours of normal operation. Provide sufficient battery capacity for operation without AC power for twenty-four hours of normal supervision and five minutes alarm operation at the end of this period; include a 20% safety factor in battery calculations to ensure adequate performance for the service life of batteries.
- G. Each signal power expander shall have an engraved plastic nameplate permanently attached indicating the devices device identification number as documented. Labels shall be 1/16" thick two-ply black/white acrylic sheet engraving stock with all sides beveled.

- H. Conduit shall enter the equipment backbox only where conduit entry is specified by the manufacturer.
- I. Provide as required Gamewell-FCI model HPF24S6/ HPF24S8, GFPS-6/GFPS-9 signal power expanders with built-in sync modules, or equivalent, match to existing.

2.7 VOICE EVACUATION SPEAKER SIGNAL POWER EXPANDERS

- A. Provide as required additional power supplies for voice evacuation speaker notification appliance circuits, for strobe notification appliance circuits, or as a remote power supply.
- B. For all power supplies serving strobe signals, the interface with the main fire alarm control panel shall carry a signal to synchronize the flash timing of all interior strobes in the system in a code 3 pattern at 1 Hz.
- C. Each power supply shall individually report a trouble condition including battery charging failure, battery failure, NAC loss, AC power loss (delay acceptable), power brownout, or ground fault detection.
- D. A trouble condition on an external power supply shall not interfere with normal operation the rest of the system.
- E. In the event of a trouble condition, each power supply shall provide location annotated individual point supervisory incident reporting to the main fire alarm control panel. This may be accomplished using one addressable module per power supply or via power supplies with multiplexed system bus communication or an integrated addressable interface.
- F. Each evacuation signal power expander supply/charger and batteries shall supply power limited 24 VDC operating and emergency power. The charger shall be capable of maintaining batteries in a fully charged state without damage and of bringing batteries from a fully discharged to a fully charged state within 48 hours of normal operation. Provide sufficient battery capacity for operation without AC power for twenty-four hours of normal supervision and five minutes alarm operation at the end of this period; include a 20% safety factor in battery calculations to ensure adequate performance for the service life of batteries.
- G. Each signal power expander shall have an engraved plastic nameplate permanently attached indicating the devices device identification number as documented. Labels shall be 1/16" thick two-ply black/white acrylic sheet engraving stock with all sides beveled.
- H. Conduit shall enter the equipment backbox only where conduit entry is specified by the manufacturer.
- I. Provide audio amplifiers as required Gamewell-FCI model INX Intelligent Network Transponders, each an assembly consisting of INI-VGX Intelligent Network Interface-Voice Gateway module, a PM-9 power supply, and up to four AM-50 Series amplifiers including a minimum of one backup amplifier, or equivalent, match to existing.

2.8 EMERGENCY VOICE/ALARM SYSTEM (VOICE EVACUATION) STROBES, SPEAKERS, AND SPEAKER/STROBES

- A. Provide where indicated on plans an emergency voice/alarm communications service system. The system shall automatically provide for speakers to broadcast a pre-recorded voice message operation on alarm that shall include an audible signal temporal pattern (Code 3) meeting ANSI S3.41 standards.

- B. The system shall also provide for manual voice capability by keying the microphone, which shall override the pre-recorded message. The system shall be capable of emergency voice announcements at any time, whether the FACP is in alarm or not. Strobe operation shall be from the FACP or SPX and synchronized. Strobe operation shall not be interrupted by microphone activation.
- C. Speakers shall be flush mount and shall feature a high fidelity 400 to 4,000 Hz frequency response with 1/4 to 2 watt audio taps, 25 or 70 VRMS (field adjustable) providing approximately 77 to 90 dB @ 10 feet, varies by model. Horn Loudspeakers frequency response shall be 400 – 14,000 Hz.
- D. Audible signals shall be tapped to provide at least 15 dB above ambient sound levels measured at 5 feet above the floor in the occupied area. Audible/Visual Signals shall conform to ADA standards. Furnish and install where shown on the drawings or as required per NFPA and any local, state, federal codes, or laws. Notification appliance circuits serving employee work areas shall be initially installed with a minimum of 20% spare capacity for visible notification appliances to facilitate future accommodation of hearing impaired employees. Strobe intensity (candela output) and audible decibel level shall be sized for the room size and area of coverage per ADA and NFPA/ANSI standards. Signal housings and grilles shall be red in color. Audible signals (strobes and strobe speakers) shall be imprinted 'FIRE' and the strobe lens shall be clear. All interior strobe flashing shall be synchronized.
- E. Provide synchronization control such that all strobe circuits are synchronous, for all notification appliance circuits - System Sensor SpectrAlert Advance model MDL3R synchronization modules or equivalent, match to existing. Note that signal appliances that can synchronize on a single circuit, but not across all circuits are not acceptable.
 - 1. Ceiling Mount Strobe Only - System Sensor SpectrAlert Advance model SCW candela range 15/30/75/95/100 or model SCRH high candela range 135/150/177 or 185 candela or equivalent, match to existing. Flush ceiling mounting requires support and a 1.5" minimum depth backbox in 4" octagon, double gang, or 4" square size. For drop ceiling installation, include a Bosch model SSB-4 or equivalent ceiling support bridge.
 - 2. Ceiling Mount Speaker Only, select models to provide intelligibility as required per area. Shall be 6.5" minimum to 8" diameter cone speakers, UL 1480 listed fire-protective signaling devices with a line supervision capacitor. Speakers shall be designed for flush mounting with white grille and feature increased wattage, approximately 1/2 up to 5 watt audio transformer taps; AMK 6.5" 25-watt rated loudspeaker coaxial enclosure with round white grille and tile bridge model SA615-EV-25v (25-v) or SA615-EV-70v (70-v), Quam 8" 20-watt rated loudspeakers with concentric mount hard fiber cone models: UL-7 round baffle (25-v), UL-5 round baffle (70-v), U22/25 2' x 2' tile replacement with integrated back box (25-v), and U22/70 2' x 2' tile replacement with integrated back box (70-v), and TOA 8" with round white grille 10-watt rated speaker, 5 watt transformer, 70.7 V and 25 V model PC-580RU with HY-BB580 Back Can and Q-HY-TB2 tile bridge, or equivalents.
 - 3. Ceiling Mount Speaker Strobes, small area – System Sensor SpectrAlert Advance model SPSCR low candela range/high fidelity, model SPSCRV low candela range/high decibel, or model SPSCR VH high candela range/high decibel. Low candela range 15/30/75/95/100 or 115, high candela range 135/150/177 or 185 candela, 1/4 up to 2 watt audio, flush mount with round white grille and trim plate – or equivalent, match to existing. Semi-flush mounting requires support and a 4" square x 2.125" deep backbox. For drop ceiling installation, include a Bosch model SSB-4 or equivalent ceiling support bridge.
 - 4. Wall Mount Strobe Only - System Sensor SpectrAlert Advance model SR candela range 15/30/75/95/100/115 or model SRH high candela range 135/150/177/185 candela or equivalent, match to existing. Flush wall mounting requires support and a 1.5" minimum depth backbox in 4" octagon, double gang, or 4" square size.
 - 5. Wall Mount Speaker Only, System Sensor SpectrAlert Advance model SPR high fidelity or model SPRV high decibel 1/4 up to 2 watt audio, flush mount with rectangular white

- grille and trim plate – or equivalent, match to existing. Semi-flush mounting requires a 4" square x 2.125" deep backbox.
6. Wall Mount Speaker Strobes – System Sensor SpectrAlert Advance Model SPSR low candela range/high fidelity, Model SPSRH high candela range/high fidelity, or Model SPSRV low candela range/high decibel. Low candela range 15/30/75/95/100 or 115, high candela range 135/150/177 or 185 candela, 1/4 up to 2 watt audio, flush mount with rectangular white grille – or equivalent, match to existing. Semi-flush mounting requires a 4" square x 2.125" deep backbox.
 7. Weatherproof exterior surface wall mount speaker strobe with audio output 1/4 up to 2 watts and visual output shall be set at 75 candela per UL 1638 and, with square white grille. Shall be System Sensor SpectrAlert Advance model SPSRK complete with wall mount plastic weatherproof back box featuring 3/4-inch top and bottom conduit entries and 3/4-inch knock-outs at the back and a screw-in NPT plug with an O-ring gasket for a watertight seal or equivalent, match to existing.
- F. Provide where indicated on plans or as required protective polycarbonate or wire Device Guards. Minimum of 1/8" thick clear polycarbonate or 10 gauge welded steel wire constriction with a corrosion resistant finish. To be Wheelock model EWR slotted horn/strobe enclosure, Space Age Electronics, Inc. models: SSU03503 HSG Wall Mount Device Guard, SSU03504 FDG Flush Wall Mount Device Guard, or SSU03500 Ceiling Mount Device Guard as required or equivalent, match to existing.

2.9 MANUAL PULL STATIONS

- A. Manual Fire Alarm Pull Stations shall be provided at all exits and where indicated on the drawings. Each addressable manual pull station shall incorporate a transmitter and receiver having a unique identification and status reporting capability to the control panel.
- B. Each manual station shall be attached to a SLC and be set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device.
- C. Manual Stations shall be double action and designed for semi-flush mounting on a standard electrical box. The station shall be constructed of hi-impact red molded Lexan or aluminum with instructions for station operation in raised white letters. The word "FIRE" shall appear on the manual station in letters one half inch in size or larger. Manual stations shall meet accessibility requirements and be operable by one hand with a five pound or less pull force.
- D. Each manual station shall be labeled in a visible area with its device hardware address utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.
- E. Stations shall provide a visible indication they have been operated. Stations shall require a key to be returned to normal condition, key alike to FACP. It is the responsibility of the Fire Alarm Contractor to ensure that the pull stations provided allow key reset with the station protector frame/spacer in place.
- F. Provide a tamper proof clear Lexan shield with horn station protector over each pull station. When the shield is lifted, a continuous audible warning horn shall be activated. Lowering and realigning the shield shall silence the horn. The horn shall provide 85 dB at 10 feet and be powered by a standard 9-volt alkaline replaceable battery. Shall be a Stopper II Manual Station Protector with horn as manufactured by Safety Technology International, Inc. Waterford, Michigan, part number STI 1100 flush mount or STI 1130 for surface mount backboxes as required. For potentially wet areas, provide a similar cover with weather gasket, part number STI 1150 flush mount or STI 1155 for surface mount backboxes.

- G. For mullion channel mount pull station locations, provide a custom made 3/16" thick aluminum backing plate 7.5" wide x 10.5" high with .5" radius canners and smooth edges. Securely attach the backing plate to the mullion channel of the framed glass wall and mount the pull station and station protector.
- H. Gamewell-FCI model MS-7AF Velociti Addressable Double Action Station or equivalent, match to existing.

2.10 SMOKE DETECTORS

- A. Analog spot type Photoelectric Smoke Detectors shall be provided where indicated on the drawings. The intelligent photoelectric detectors shall be resettable from the FACP. The detectors shall operate by the photoelectric light-scattering principal using an LED light source to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. The detector shall provide automatic sensitivity drift compensation to provide long term stability and reliability. The detector shall also provide a maintenance alert feature whereby the detector shall initiate a trouble condition should the units' sensitivity approach the outside limits of the normal sensitivity window. In addition, the detector shall also be provided with extensive RF and EMF noise immunity. Detectors shall withstand wind gusts to 4,000 feet per minute without false alarming or initiating a trouble indication.
- B. The detector shall provide a calibrated test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself, by activating a magnetic test switch, or may be activated remotely on command from the control panel.
- C. Each smoke detector shall be attached to a SLC and set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device.
- D. The detectors shall provide dual alarm and power/status LEDs. Status LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected and verified.
- E. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist-lock base. Detectors shall be provided in smooth attractive white finish, and be sealed against dirt, vermin, and backpressure. Detectors shall be provided with fine mesh insect/contaminate screen. Detectors shall be UL listed with respective control panel.
- F. Each detector head shall be labeled in a visible area with its device hardware address utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.
- G. Analog smoke detectors shall communicate analog values using a digital protocol to the control panel for the following functions:
 - 1. Automatic compliance with NFPA 72 standards for detector sensitivity testing
 - 2. Drift compensation to assure detector is operating correctly
 - 3. Maintenance alert when a detector nears the trouble condition
 - 4. Trouble alert when a detector is out of tolerance
 - 5. Alert control panel of analog values that indicate fire.
- H. Except for temporary testing, smoke detectors shall not be installed until the building is ready for occupancy and cleaned as dust free as possible.
- I. Gamewell-FCI model ASD-PL2F with B210LP 6" base, or equivalent, match to existing.

2.11 HEAT (THERMAL) DETECTORS

- A. Analog spot type combination rate of rise and fixed thermal detectors shall be provided where indicated on the drawings. The intelligent thermal detectors shall connect via two wires to an intelligent control panel loop and be resettable from the FACP. The detectors shall use dual electronic thermostats to measure temperature levels in its chamber and provide fast response to rapid rate of rise in temperature. The detector shall, on command from the control panel, send data to the panel representing the analog temperature level.
- B. The fixed temperature element shall be rated at 135° Fahrenheit for areas where ambient temperatures do not exceed 100° Fahrenheit, and 200° Fahrenheit for areas where the temperature does not exceed 150° Fahrenheit.
- C. The rate of rise element shall operate when the rate of temperature rise exceeds 15° Fahrenheit per minute.
- D. The detectors shall provide a calibrated test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself, by activating a magnetic switch, or may be activated remotely on command from the control panel.
- E. Each thermal detector attached to a SLC and shall be set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device.
- F. The detectors shall provide dual alarm and power/status LEDs. Status LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected.
- G. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist-lock base. Detectors shall be provided in smooth attractive white finish. Detectors shall be UL listed with respective control panel.
- H. Each detector head shall be labeled in a visible area with its device hardware address utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.
- I. Gamewell-FCI model ATD-RL2F combination 15° minute rate-of-rise temperature sensor with 135° fixed temperature alarm, ATD-HL2F high temperature detector variable 135°F to 190°F, with B2101LP 6" base, or equivalent, match to existing.

2.12 ISOLATOR MODULE

- A. Provide isolator modules in each SLC loop placed between every 25 or less devices. The isolator modules shall isolate wire-to-wire short circuits on a SLC loop, which shall limit the number of other modules, or detectors that are incapacitated by the short circuit fault. If a wire-to-wire short occurs, the isolators on either side of the short shall automatically open-circuit. When the short is corrected, the isolators shall automatically re-connect the isolated section of the loop.
- B. The isolator module shall not require any address-setting, although each isolator may electrically reduce the capacity of the SLC loop by one detector or module address. The isolator module may be built into selected detector bases or mount in a standard 4-inch electrical box. Provide an LED, which shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short has been detected and isolated.

- C. Gamewell-FCI model M500X isolation module or equivalent, match to existing.

2.13 MONITOR MODULE [MM]

- A. Addressable Monitor Modules shall be provided where an interface is required to supervise wiring and monitor contact alarm devices. Monitor modules shall be mounted in a 4-inch square electrical box with cover.
- B. Each monitor module shall be set to a distinct address and internal identification code on the SLC, which the control panel shall use to identify the location, status, and type of device. A status/power LED shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel. The status LED shall illuminate steady upon detection of an alarm condition.
- C. Each monitor module shall provide for automatic functional testing of the device from the main control panel and the module shall reset when the panel is reset. Results of the test shall then be indicated on the LCD display.
- D. Each monitor module shall have an engraved plastic nameplate permanently attached indicating the device function and control panel device identification number. Labels shall be 1/16" thick two-ply black/white acrylic sheet engraving stock with all sides beveled.
- E. Monitor Module to supervise an IDC zone interface for compatible 2 or 4-wire circuit powered 24 volt normally open conventional smoke or heat detectors - Gamewell-FCI model AMM-4SF Addressable Monitor Module or MMI-6SF Multi-Mod Six Zone Interface Module with end of line devices as required, or equivalent, match to existing.
- F. Monitor Module to supervise an IDC zone interface for normally open dry-contact, 2-wire, or 4-wire type conventional initiating devices, which may be non-powered or powered by a separate circuit - Gamewell-FCI model AMM-2F Miniature, AMM-4F, AMM-2IF Dual, AMM-2IF Dual Input/Output, MMI-6SF Multi-Mod Six Zone Interface Module, or MMI-10F Multi-Mod-10 Input Module or equivalent with end of line devices as required.

2.14 CONTROL MODULE [CM]

- A. Addressable Signal Control Modules shall be provided where required to provide a NAC control interface for fire alarm signal functions. Control Modules shall be mounted in a 4-inch square electrical box with cover.
- B. Power to operate the relay actuation shall be provided by the SLC. Each control module shall be operated by events as programmed in the control panel (i.e. operate on alarm condition). Each control module shall feature a status LED to indicate the module is operational and when the relay is energized.
- C. Each control module shall be set to a distinct address and internal identification code on the SLC, which the control panel shall use to identify the location, status, and type of device.
- D. Each control module shall have an engraved plastic nameplate permanently attached indicating the device function and control panel device identification number. Labels shall be 1/16" thick two-ply black/white acrylic sheet engraving stock with all sides beveled.
- E. Control Modules for control of NAC interface fire alarm functions - Gamewell-FCI model MMO-6SF Multi-Mod - 6 Signal Output or equivalent, match to existing.

2.15 CONTROL RELAY [CR]

- A. Control Relays (Addressable Control Modules) shall be provided where required to provide a control interface for fire alarm system functions. Control relays shall be mounted in a 4-inch square electrical box with cover.
- B. Power to operate the relay actuation shall be provided by the SLC. Each control relay shall be operated by events as programmed in the control panel (i.e. operate on general alarm, conditional on the detection of an alarm condition in one or more designated adjacent area smoke detectors, or other conditional operations such as elevator recall). Each control module shall feature a status LED to indicate the module is operational and when the relay is energized.
- C. Each control relay shall be set to a distinct address and internal identification code on the SLC, which the control panel shall use to identify the location, status, and type of device.
- D. Each control relay shall have an engraved plastic nameplate permanently attached indicating the devices function and control panel device identification number. Labels shall be 1/16" thick two-ply black/white acrylic sheet engraving stock with all sides beveled.
- E. Addressable Control Relays shall be located within three feet of the controlled device or unit and the relay output (load) wiring shall be configured as a fail-safe Fire Safety Control Function circuit.
- F. Each Fire Safety Control Function circuit controlled device shall be configured such that when the fire alarm system safety control function circuit is re-energized, by the fire alarm control panel, the device shall return to normal operation (e.g. re-start or be ready to re-start) without a need for manual or environmental control system intervention.
- G. Addressable Control Relays shall be used to directly control only pilot duty loads, those not exceeding 0.5 amps, up to 120 volts, and without transient voltage spikes. For all applications exceeding these parameters also provide with an Auxiliary Relay to handle the load.
- H. Control Relays for fire alarm functions, shall include SPDT dry contacts (form C) relay - Gamewell-FCI model AOM-2RF Addressable Relay Control Module, AOM-2SF Addressable Relay Supervised Control Module, MMO-6RF Multi-Mod - 6 Relay Output, AMM-2IF Dual Input/Output or equivalent, match to existing.

2.16 AUXILIARY RELAY [XR]

- A. Provide a hardwired Auxiliary Relay paired with the addressable Control Relay for all fire safety control function applications in which the load exceeds 0.5 amps, 120 volts, or with high transient voltage spikes.
- B. Each relay shall be mounted in a surface mount red metal enclosure with conduit knockouts. Relays shall be UL recognized and rated for ten million mechanical operations.
- C. Single pole standard duty Auxiliary Relays shall be operated by a multi-voltage coil (24 VDC, 24 VAC, 120 VAC, or 230 VAC), feature SPDT dry Form C contacts rated 10 Amps @ 120 VAC, and a status LED to indicate that the relay is energized. Provide Air Products & Controls model MR-101/C/R, multi-voltage coil, control relay with red metal enclosure or approved equivalent.
- D. Double pole standard duty Auxiliary Relays shall be operated by a multi-voltage coil (24 VDC, 24 VAC, 120 VAC, or 230 VAC), feature DPDT dry Form C contacts rated 10 Amps @ 120 VAC, and a status LED to indicate that the relay is energized. Provide Air Products & Controls

model MR-201/C/R, multi-voltage coil, control relay with red metal enclosure or approved equivalent.

- E. Double pole heavy duty Auxiliary Relays shall be operated by a 24 VDC or a 120 VAC coil and feature DPDT dry Form C contacts rated at 30A @ 240VAC; 20A @ 277VAC; 2HP @ 240VAC / 1.5HP @ 120VAC. Provide Air Products & Controls model MR-199X-13/C/R (24VDC coil) or MR-199X-14/C/R (120 VAC coil) as required, heavy duty relay with red metal enclosure or approved equivalent.

2.17 DUCT MOUNTED SMOKE DETECTORS

- A. Duct mounted detector housings with intelligent photoelectric detector heads shall be provided where shown on the drawings, or as required. Detectors shall operate by the photoelectric light-scattering principal using an LED light source to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. The detector shall operate in air velocities of 300 to 4,000 ft./min. without a shift in sensitivity. Each detector shall be resettable from the FACP.
- B. The unit shall include a 16-gauge steel or Noryl molded plastic enclosure with molded integral conduit knockouts. The unit shall be provided with gasket seals to provide proper sealing of housing to mechanical ductwork and to ensure proper airflow into the detector sampling chamber. Duct housing shall be designed for mounting to rectangular or round ducts.
- C. Each duct mounted detector housing shall be labeled in a visible area with its device hardware address utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.
- D. The Duct Detector Unit shall be UL listed to the most current UL 268A standard and be cross-listed for use with the fire alarm control panel. Each duct unit shall be equipped with sampling tubes protruding into the associated ductwork. For ducts up to 3' wide, the supply tube shall be 1" shorter than the duct width. For ducts 3' to 8' wide the sampling tube to be 1" longer than the duct width and protrude through the opposite side of the duct for support. Duct widths greater than 8' will require internal bracing. Sampling tubes shall be configured to provide adequate airflow through the detector housing and fitted with an integral porosity filter system to aid in reducing detector contamination. Detectors shall be installed per NFPA 90A and the manufacturer's instructions.
- E. When smoke is detected by a duct mounted smoke detector it shall activate a supervisory fire alarm condition at the fire alarm control panel. Duct mounted smoke detectors are not a substitute for area detection. The activation of any duct mounted smoke detector shall actuate all related fire safety control functions: air handler shut down relays, smoke fire damper motors, fire door release devices, et cetera.
- F. Each smoke detector shall be attached to a SLC and set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device. Duct detectors must be powered from the fire alarm system.
- G. Each detector shall be provided with a remote power/status LED. The remote LED indicator shall be located in the nearest corridor ceiling unless otherwise directed. The status LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. The LED shall be placed into steady illumination when a supervisory condition has been detected.
- H. Each remote LED faceplate shall have an engraved plastic nameplate permanently attached indicating the HVAC unit number, type, and device identification number as programmed in panel. Labels shall be 1/16" thick two-ply black/white acrylic sheet engraving stock with all sides beveled.

- I. Each HVAC unit for which a Duct mounted Smoke detector is installed shall also have a blower shutdown relay as listed below.
- J. Duct mounted smoke detector housings and sample tubes shall be furnished by the Fire Alarm Contractor and mounted by the Mechanical Contractor. Coordinate with the mechanical contractor.
- K. It is also acceptable for smoke detectors that are UL listed to UL 268A specifically for use in no-flow/low-flow air-handling systems to be pendant / plate mounted in the duct air stream (without sampling tubes). Pendant mounted duct smoke detectors shall be installed in accordance with the manufacturers' instructions and shall be easily accessible for service, with a labeled access door or removable plate and a remote LED.
- L. Gamewell-FCI model DNR housing with base and ASD-PL2FR photoelectric detector head, DSTx series sampling tube, ETX metal exhaust tube duct, and RA100Z remote LED or equivalent, match to existing.

2.18 HVAC UNIT BLOWER SHUT-DOWN AND SMOKE DAMPER OR FIRE/SMOKE DAMPER OPERATION

- A. The contractor providing the device shall wire it internally for fail-safe shut-down and provide a labeled 3' coil of cable outside the unit to allow the fire alarm contractor to make final connection to the dry contacts on the controlling relay.
- B. Provide an addressable control relay to control air handler shutdown of each unit without smoke dampers or fire/smoke dampers located in that unit's duct system as indicated on the project plans.
- C. Provide an addressable control relay, a double pole auxiliary relay, and a line voltage 120 VAC, fire safety control function circuit to control air handler shutdown of each unit with smoke dampers or fire/smoke dampers located in that unit's duct system as indicated on the project plans.

2.19 AUTOMATIC FIRE SUPPRESSION SYSTEMS

- A. All automatic fire suppression systems shall be monitored by the fire alarm system. The activation of any automatic fire suppression system shall produce an alarm condition.
- B. The kitchen ventilation hood suppression system shall provide contacts to monitor activation of system, coordinate with existing conditions and the Food Service Equipment Contractor. Provide monitor modules as required for alarm functions.

2.20 ELECTROMAGNETIC DOOR HOLD BACK AND RELEASE

- A. Provide electromagnetic door hold back and release devices as shown on the project plans or as required.
- B. Provide required devices and connections for holdbacks integrated into door systems when supplied.
- C. The fire alarm contractor shall verify voltages, exact style, and quantity required with architectural plans and door schedules.

- D. Secure hardware to door drilled through with “Chicago Bolts” (barrel nut/mating screw with a low profile head on each side) to prevent pull out. Provide blocking in wall for hardware attachment.
- E. Operating power and line voltage wiring of the 120 VAC, fire safety control function circuit is to be provided by the Electrical Contractor.
- F. Provide an addressable control relay, a single pole auxiliary relay, and a line voltage 120 VAC, fire safety control function circuit for 120 VAC holdbacks.
- G. Provide an addressable control relay, a single pole auxiliary relay, a line voltage 120 VAC, fire safety control function circuit, and a UL listed Class 2 transformer, 120 VAC primary/24 VAC secondary, 20 VA output, for 24 VAC holders. Transformer shall be an Edwards model number 592 with number 593 mounting plate or equivalent.
- H. Unless otherwise provided with door assembly, supply Rixson Firemark FM-998 series, Edwards model DH150A or 1504-AQN5 series door holders; 24 VAC, mounting style, single or double, as required, or equivalent.

2.21 SPRINKLER RISER WATERFLOW AND TAMPER SWITCHES

- A. Waterflow switches shall be provided and installed by the sprinkler system contractor and should meet the following requirements:
 - 1. Integral, mechanical, non-coded, non-accumulative retard type device with a normally open dry contact for supervision by the fire alarm system.
 - 2. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30 – 45 seconds.
 - 3. Flow switches shall be located a minimum of one (1) foot from a fitting that changes the direction of the flow and a minimum of three (3) feet from a valve.
- B. Sprinkler and standpipe valve supervisory switches shall be provided and installed by the sprinkler system contractor and should meet the following requirements:
 - 1. Each sprinkler system water supply control valve riser or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch device with a normally open dry contact for supervision by the fire alarm system. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
- C. Each Post Indicator Valve (PIV) or main gate valve shall be equipped with a supervisory switch.
 - 1. Mount switch so as not to interfere with the normal operation of the valve and adjust 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.
 - 2. The mechanism shall be contained in a weatherproof aluminum housing that includes a 3/4-inch tapped conduit entrance and incorporates the necessary facilities for attachment to the valves.
 - 3. Switch housing to be finished in red baked enamel.
 - 4. 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.
- D. When applicable, provide dry contact input fire alarm system monitor modules for individual additional water flow alarm, fire pump running alarm, and other contacts indicating a supervisory condition.
- E. All wiring, monitor modules, end of line devices, and connection to the fire alarm system shall be by the fire alarm contractor.

- F. Each waterflow switch shall actuate an individually annunciated, by sprinkler riser zone, alarm condition at the fire alarm control panel.
- G. All alarm and supervisory conditions shall annunciated at the panel and transmitted to the monitoring service by the digital communicator.
- H. Valve tamper switches and other supervisory devices as required shall initiate a supervisory condition and may be grouped up to twenty devices per IDC when acceptable to the AHJ. Grouping shall be limited to risers within the same room by this specification. Coordinate with Section 21 13 14.
- I. Provide addressable monitor modules with end of line devices as required.

2.22 CABLING (PLENUM RATED)

- A. The fire alarm contractor shall provide and install new and unused ASTM bare solid or stranded copper conductor cable per ANSI/NEMA and NFPA codes. Follow the manufacturer's instructions. All cable shall be UL listed for fire protective, power limited applications. All cable exposed in plenum attic spaces shall comply with UL 910, UL 1424, and UL 1581 vertical tray flame test.
- B. Cabling shall be in accordance with local, state, and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
- C. Cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLP).
- D. Signaling Line Circuit (SLC): Use shielded or unshielded cabling as recommended by the FACP manufacturer. When recommended, shielded cable should be utilized to minimize electrical noise interference with data transmission. All wiring for intelligent/addressable data circuits shall be shielded twisted pair, low capacitance, NEC type FPLP, West Penn Wire number D60975 - 18 AWG, number D60991 - 16 AWG, or number D60992 - 14 AWG, overall shield 100% aluminum polyester foil, data cable, one twisted pair. Shield drain wire to be grounded at one end only. Equivalent by Atlas, Belden, BSCC, or Remece.
- E. Between Building Signaling Line Circuit (SLC) or Network Node Circuits: Cabling between buildings shall be enclosed in conduit, including underground and over canopy installations. Cable used between buildings shall be rated for direct burial. Cable shall be moisture, abrasion, and crush resistant. Use shielded or unshielded cabling as recommended by the FACP manufacturer. When recommended, shielded cable should be utilized to minimize electrical noise interference with data transmission. All between building wiring for intelligent / addressable data or network node circuits shall be shielded twisted pair, low capacitance, NEC type FPL Direct Burial, West Penn Wire number AQ293 - 18 AWG or number AQ294 - 16 AWG, Aquaseal, overall shield 100% aluminum polyester foil, data cable, one twisted pair. With water blocked construction and overall 105° C sunlight and moisture resistant PVC jacket. Shield drain wire to be grounded at one end only. Equivalent by Atlas, Belden, BSCC, or Remece.
- F. Voice Evacuation Notification Appliance Circuits (Voice NAC): Cabling shall be shielded twisted pair, NEC type FPLP, West Penn Wire number 60975B - 18 AWG, number 60991B - 16 AWG, number 60995B - 14 AWG, or number 60991B - 12 AWG overall shield 100% aluminum polyester foil, audio cable, one twisted pair with 20 AWG stranded tinned copper

drain wire. Shield drain wire to be grounded at one end only. Equivalent by Atlas, Belden, BSCC, or Remee.

- G. Visual Notification Appliance Circuit (NAC): All visual signaling circuits shall be NEC type FPLP, West Penn Wire number 50972 - 14 AWG, or number 50974 - 12 AWG, two conductor signaling cable. Equivalent by Atlas, Belden, BSCC, or Remee.
- H. Initiating Device Circuits (IDC): All conventional contact alarm circuits and low voltage control circuits shall be NEC type FPLP, West Penn Wire number 50971 - 16 AWG, number 50972 - 14 AWG, or number 50974 - 12 AWG, two conductor signaling cable. Equivalent by Atlas, Belden, BSCC, or Remee.

2.23 CABLE TIE WRAPS (PLENUM RATED)

- A. Plenum rated Velcro hook cable ties shall be furnished and installed to attach wire bundles to supports and for appropriate wire management as required. Provide and install Panduit TAK-TY HLTP series cable ties with UL 94-V2 flammability rating, or equivalent.
- B. Tie wraps made of **hard plastic or metal will not be allowed on this project.**

2.24 CABLE ROUTING, INSTALLATION, AND SUPPORT

- A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the NFPA and the Texas Insurance Code. Wiring shall meet all state and local electrical code requirements.
- B. Power-limited fire alarm conductors and cables described in NEC section 760.179 shall be installed as detailed in 760.130(B)(1), (B)(2), or (B)(3) of this section and 300.7. Devices shall be installed in accordance with 110.3(B), 300.11(A), and 300.15.
- C. Cable pathways, conduit, and cable support systems shall be complete with bushings, deburred, cleaned, and secure prior to installation of cable.
- D. All wiring shall test free from opens, grounds, or shorts. All fire alarm cable shall be supported from the building structure and bundled. Do not attach any supports to joist bridging or other lightweight members. The support system shall provide a protective pathway to eliminate stress that could damage the cabling. The cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends that could compromise the integrity of the cabling.
- E. Fire alarm cable must not be fastened to electrical conduits, mechanical ductwork/piping, sprinkler pipes. Cable routing must not obstruct access to hatches, doors, utility access panels, or service work areas. Do not route cables through fire doors, ventilation shafts, grates, or parallel for more than four-feet with line voltage electrical conductors. Fire alarm cables shall not be run loose on ceiling grid or ceiling tiles.
- F. In all exposed areas such as gymnasiums, shops, field houses, janitors' closets, elevator hoistways, and mechanical / electrical rooms all fire alarm cable shall be fully enclosed in conduit.
- G. Fire alarm cables shall be run in conduit stubs from wall boxes to accessible areas above finished ceilings. Conduit shall be required only within walls and concealed spaces to provide access. Provide bushings to protect the cable from damage for conduit ends, box openings, and passage through metal studs.

- H. Fire alarm cables shall be run in bundles above accessible ceilings and supported from building structure by j-hooks, conduit or cable tray. Cabling shall be loosely bundled with cable ties randomly spaced at 30 to 48 inches on center, cable ties shall not be tight enough to deform cabling and shall not be used to support the cabling.
- I. Support shall be provided by mounting appropriate fasteners that may be loaded with multiple cables. Provided that the weight load is carried by the support rod or wire, the support assembly may attach to the ceiling grid for lateral stabilization. The required support wires for the ceiling grid or light fixtures shall not be utilized. Any fastener attached to the ceiling grid shall not interfere with inserting or removing ceiling tiles. The cable pathway of supports must be positioned at least 12 inches above the ceiling grid.
- J. All cabling shall be placed with regard to the environment, EMI/RFI interference, and its effect on fire alarm signal transmission.
- K. Do not route any fire alarm cable within two feet of any light fixture, HVAC unit, service access area, electric panel, or any device containing a motor or transformer.
- L. Fire alarm cable will not be installed in the same conduit, raceway, tray, duct, or track with line voltage electrical cable without a metallic barrier meeting NEC requirements.
- M. Maximum cable pulling tension should not exceed 25 pound-force (110 N) or the manufactures recommendation, whichever is less.
- N. Any pulling compounds utilized must be approved by the cable manufacturer and shall not degrade the strength or electrical characteristics of the cable.
- O. No terminations or splices shall be installed in or above ceilings.
- P. Cable bends shall not be tighter than the manufacturers' suggested bend radius.
- Q. Mount all equipment firmly in place such that vibration or jarring will not activate an alarm, supervisory, or trouble signal. Cabling shall be routed in a professional, neat, and orderly manner.
- R. All cable shall have a label on both ends utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.
- S. Each cable run shall include a three-foot service loop with wire tie located in the ceiling above the control unit panel. This is to allow for future re-termination or repair.
- T. Provide for adequate ventilation to all equipment racks and take precautions to prevent electromagnetic or electrostatic hum.
- U. All conduit, ducts, track, and raceways shall be supported from the structure at industry standard intervals for the size specified, utilizing proper anchoring devices. Cable fill may not exceed the manufacturers' instructions for each type of support.
- V. All conduit, duct, track, and raceway runs shall be spaced apart to allow for maintenance, such as the installation of couplings, without disturbing adjacent pathways.

2.25 TERMINATION PRACTICES

- A. Strip back only as much cable jacket as required to terminate.

- B. Do not "loop" over wiring terminals, the cable could come loose and the condition not be detected as an open circuit or disconnected device.
- C. Preserve wire twists as closely as possible to point of termination (0.5" maximum) to keep signal impairment to a minimum.
- D. Avoid twisting cable jacket during installation.

2.26 BUSHINGS

- A. Provide a plastic snap in bushing at each box opening, passage through a metal stud, and at the end of all open conduit stubs or sleeves prior to cable installation to protect the cabling from damage:
 - 1. Box openings - Thomas & Betts Knockout Bushing Series 3210, or equivalent.
 - 2. Metal stud passage - Thomas & Betts Twist It Bushing Catalog Number SB1216-SC, or equivalent.
 - 3. Conduit ends - Thomas & Betts Anti-Short Bushing Series 390 or Tite-Bite Combination Coupling Series 442, or equivalent.

2.27 CEILING MOUNTED DEVICE BOX HANGERS

- A. All ceiling mounted devices including: smoke detectors, heat detectors, remote power/status LEDs, ceiling mounted strobes and horn/strobes, et cetera, when mounted in a drop ceiling shall be supported by an electrical box hanger (Caddy #512 or #512A for deep boxes - 24" span), or equivalent. Box hangers shall be attached to the ceiling grid only for lateral stabilization, separate support wires shall be provided. The required support wires for the ceiling grid or light fixtures shall not be utilized. The backbox shall be flush and level with the bottom of the ceiling tile and the hole neatly cut for a finished appearance when the device is installed.
- B. Device and box hanger assemblies shall not be supported solely by suspended ceilings. Fasteners and supports shall be adequate to support the required load.

2.28 J-HOOKS

- A. Attachments for cabling support shall be spaced at approximately 48 to 60 inches on center. The cable bundle shall not be allowed to sag more than 12 inches mid-span between attachments. Attachments shall be sized as follows:

Single cables or bundles up to four cables may be supported directly by the building structure.

Bundles up to 1/2" diameter (Ten 1/4" cables)	2" bridle ring, Caddy #4BRT32 or equivalent
Bundles up to 3/4" diameter (Sixteen 1/4" cables)	3/4" J-Hook, Caddy #CAT12 or equivalent
Bundles up to 1-5/16" diameter (Fifty 1/4" cables)	1-5/16" J-Hook, Caddy #CAT21 or equivalent
Bundles up to 2" diameter (Eighty 1/4" cables)	2" J-Hook, Caddy #CAT32 or equivalent

Split bundles greater than 2" diameter or provide cable tray.

- B. Do not mix different signal strength cables on the same J-Hook (i.e. fire alarm with telephone/data cable). Multiple J-Hooks can be placed on the same attachment point, up to the rated weight load of the attachment device.

2.29 SURGE PROTECTION FOR FIRE ALARM CONTROL UNITS

- A. In addition to the built-in panel surge protection, each incoming 120VAC power circuit shall be provided with an electrical surge protection module. Provide one for each fire alarm control unit, this shall include every fire alarm control panel, digital communicator, signal power expander and any other 120VAC powered fire alarm control units. Each power circuit surge protector module shall be mounted in a standard metallic electric box that is grounded. Module shall be hardwired in the incoming power circuit and 20 amp rated. Units shall provide surge protection (UL 1449 3rd edition listed), noise filtering (UL 1283 listed), and nanosecond reaction three-stage MOV line protection. Shall be Ditek DTK-120SRD or equivalent.

2.30 FIRE ALARM CIRCUIT SURGE PROTECTION

- A. Provide surge protection shall be provided for all exterior devices, communications service, or antenna entrance connections, and for each circuit that connects one building to another (i.e. any other portion of a building complex not under one continuous roof) at both entry/exit points to prevent damage to equipment.
- B. Each surge protector shall be mounted in a standard grounded metallic electric box or equipment backboard with a separate ground wire ran directly to the ground bus bar or equipment panel ground stud, do not daisy chain ground wires.
- C. Surge protectors for low voltage communications signal and control circuits with a data rate from 200kbps to 2Mbps, nominal voltage as listed below AC or DC. Each module shall protect up to two pairs using hybrid design multi-stage SAD technology, shall be Ditek 2MHLP series field replaceable modules with MB Series mounting bases for one to five modules, or equivalent, model numbers as follows:
 - 1. 70 to 75 Volt circuit, 4 wire protector with base DTK-2MHLP75BWB.
 - 2. 48 to 50 Volt circuit, 4 wire protector with base DTK-2MHLP48BWB.
 - 3. 36 Volt circuit, 4 wire protector with base DTK-2MHLP36BWB.
 - 4. 24 Volt circuit, 4 wire protector with base DTK-2MHLP24BWB.
 - 5. 12 Volt circuit, 4 wire protector with base DTK-2MHLP12BWB.
 - 6. 0 to 6 Volt circuits, 4 wire protector with base DTK-2MHLP5BWB.
- D. Surge protectors for low voltage communications high data rate voice, data and signaling data and loop circuits, or serial communication, nominal voltage as listed below AC or DC. Each module shall provide Line-Ground (All) protection modes, maximum surge current: 2,000 Amps per pair (6V-50V) or 9,000 Amps per pair (75V-130V), and maximum continuous current: 5 Amps to 0.15 Amps, shall be Ditek LVLP series or equivalent, model numbers as follows:
 - 1. 115 to 130-Volt circuit, 2-pair protector, 10-12 AWG, DTK-2LVLAWGRUV.
 - 2. 95-Volt circuit, 2-pair protector, 10-12 AWG, DTK-2LVLAWGSGR.
 - 3. 75-Volt circuit, 2-pair protector, 10-12 AWG, DTK-2LVLAWGSPK.
 - 4. 48 to 50-Volt circuit, 2-pair protector, 16-22 AWG, DTK-2LVLPPOPX.
 - 5. 24 to 30-Volt circuit, 2-pair protector, 16-22 AWG, DTK-2LVLPPLV.
 - 6. 12 to 14-Volt circuit, 2-pair protector, 16-22 AWG, DTK-2LVLPX.
 - 7. 0 to 6-Volt circuit, 2-pair protector, 16-22 AWG, DTK-2LVLPD.
 - 8. 0 to 6-Volt circuit, 8-pair protector (RS-485, RS-232), 16-22 AWG, DTK-8LVLPPLVD.

2.31 FIRE STOPPING, DRAFT/NOISE STOPPING, PENETRATIONS, AND CORING

- A. UL Listed fire stopping methods that match the fire rating of the wall or floor being penetrated are to be used at all fire barrier penetrations. Seal the interior of the conduit sleeve around the cables and around the outside of the sleeve on each side of the penetration with fire-stop caulk or putty, install according to the manufacturers' instructions.

- B. All penetrations through fire rated walls or floors shall feature a suitable length of metal conduit. Hole diameter shall not exceed ½" larger than the conduit or sleeve to be installed. The hole shall be neatly cut, not oversize or irregular. Do not share wall/floor penetrations with ductwork, piping, line voltage electrical conduits, etc.
- C. All gypsum board or plaster penetrations shall tool cut using an appropriate hole saw / mandrel or manufactured assembly.
- D. Draft/Noise Stopping - All penetrations through non-rated walls shall include draft/noise stopping to minimize the transfer of air and sound between enclosed areas. This shall include but not limited to:
 - 1. Neatly cutting all non-rated wall penetrations with a 1" maximum clearance. All gypsum board or plaster penetrations shall be tool cut using an appropriate hole saw / mandrel or manufactured assembly. The hole shall be neatly cut and not oversize or irregular. Do not share wall penetrations with other types of ductwork, piping, line voltage electrical conduits, communications cabling, etc.
 - 2. Provide and install non-combustible mineral wool, fiberglass, cellulose insulation, caulk, and/or sealant as required. Seal the interior of conduit sleeves around the cables and around the outside of the sleeve on each side of the penetration with caulk or putty, install materials according to the manufacturers' instructions.
- E. The Contractor shall make every effort to coordinate with the building Architect, Engineer, Builder, and Electrical Contractor to have sleeves placed in new construction so that later coring or drilling of building structural members will not be required. The Contractor must consult with the building Architect, Engineer, and Builder prior to drilling, coring, or sawing of any wall, floor, etc. All penetrations shall be made at approved, appropriate, locations.
- F. Upon approval, the Contractor shall be required to supply all labor, equipment, tools, and materials to create any additional penetrations, and shall provide the sleeve, temporary and final fire stopping. Special care shall be taken not to stress, overheat, or penetrate any building support member. Coring shall be made with equipment appropriate for the dry penetration of concrete and block materials. Under no circumstances shall penetrations be made utilizing a chisel or percussion type equipment. Concrete, block, or plaster cores shall be made by dry saw/core methods only.

PART 3 – EXECUTION

3.1 REVISION OF THE EXISTING FIRE ALARM SYSTEM FOR RENOVATION

- A. The fire alarm contractor shall be responsible for rework of portions of the existing fire alarm system. This shall also include demolition of any devices and cable previously abandoned. Demolition shall include disconnection and removal of all devices not to be reused and off-site disposal, in a legal manner, of all materials not requested to be turned over to the Owner. Comply with government regulations pertaining to environmental protection, and disposal of materials and equipment. Do not burn any materials on the site.

3.2 EXAMINATION

- A. Verify existing field conditions, circuiting arrangements, cabling, and devices served in areas as shown on the Drawings. Adjust all circuiting, cabling, and materials to be provided as required by job conditions.
- B. Identify and verify abandoned equipment, wiring, and devices. All visible disconnected or abandoned devices and cabling shall be removed i.e. non-functional fire pulls, bells, speakers, signals, et cetera.

- C. Drawings are based on casual field observation and existing record documents. Report discrepancies to the Engineer before disturbing existing installation.
- D. The Contractor accepts the existing conditions when beginning demolition.

3.3 PREPARATION

- A. Disconnect fire alarm devices in walls, floors, and ceilings as shown or required.
- B. Provide temporary wiring and connections as required to maintain the operation of existing systems during construction.
- C. When work must be performed on energized equipment or circuits use personnel experienced in such operations. Verify phasing on existing equipment and coordinate new phasing before energizing revised service.
- D. Remove, relocate, and extend existing installations to accommodate new construction as required.
- E. Remove abandoned wiring to the source of the supply.
- F. Remove exposed abandoned conduit, including abandoned conduit, brackets, stems, hangers, and other accessories above accessible ceiling finishes. Cut conduit flush with walls, floors, and patch surfaces.
- G. Disconnect and remove abandoned devices. Remove abandoned devices if conduit servicing them is abandoned and removed. Provide blank cover for abandoned devices that are removed in masonry construction.
- H. Disconnect and remove fire alarm devices and equipment serving equipment that has been removed.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Confirm with Owner/Architect regarding the handling and disposal/reuse of removed material, equipment, devices, et cetera.

3.4 OPERATION PRIOR TO COMPLETION

- A. When the phasing of a project requires that fire alarm, systems are operable in certain areas and the Owner needs to operate the equipment, such provisions shall be made by the contractor. The warranty period shall commence when the equipment is operated for the beneficial use of the Owner. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust, and complete all punch list items before final acceptance by the Owner. The date of acceptance and the start of the warranty may not be the same date.

3.5 SIGNAL TYPES (SYSTEM STATUS)

- A. General: The Fire Alarm Control Panel shall indicate various conditions or signals depending on system inputs. In all instances, a more severe signal shall override all less severe signals. All events are to be recorded with time and date in an electronic event history log maintained by the fire alarm control panel. The following is a short description of conditions that the Fire Alarm Control Panel is required to indicate in order of severity:
 - 1. WATERFLOW FIRE ALARM: A waterflow signal is a special alarm condition that is only applicable when an automatic building sprinkler or similar system is monitored. It

indicates that at least one sprinkler head is open, so in addition to a fire, the premises are subject to water damage. This signal is transmitted on a special channel on the digital communicator. This is a fire alarm condition and all actions listed under fire alarm shall take place.

2. FIRE ALARM: This alarm signal is indicative of fire. Such a signal indicates an emergency requiring immediate action. All premises audible and visual notification appliances shall operate and the protected premises evacuated. A local audible alert shall sound, the alarm LED illuminate, and descriptive message appear on the LCD display at the panel and any remote annunciators until the panel is reset. The digital communicator transmits a fire alarm signal.
3. SUPERVISORY ALARM: A supervisory signal indicates the need for action concerning a duct mounted smoke detector, monitored fire suppression system, or the maintenance of related systems. The tamper switch on a sprinkler riser is a supervisory condition because the system cannot function with a closed valve. An audible alert shall sound, the supervisory LED illuminate, and descriptive message appear on the LCD display at the panel and any remote annunciators until silenced. The digital communicator transmits a supervisory signal.
4. TROUBLE: A trouble signal indicates a fault in a monitored circuit or component of the fire alarm system. This could be a short, open, or ground in a supervised circuit. It could also indicate a device or battery failure. A local audible alert shall sound, the trouble LED illuminate, and descriptive message appear on the LCD display at the panel and any remote annunciators until silenced. The digital communicator transmits a trouble signal.
5. MAINTENANCE ALERT: A maintenance alert is an early warning of a condition before a device becomes inoperable. Often this smoke detector needs cleaning or other normal maintenance item. The maintenance alert shall display on the panel and any remote annunciator LCD display until acknowledged. No audible alert shall sound and no signal transmitted, in order that this condition is not confused with a supervisory or trouble condition.
6. NORMAL: All systems and supervised circuits functioning normally.

3.6 SEQUENCE OF OPERATION

- A. Alarm Condition: When a fire alarm condition is indicated by any manual pull station, heat detector, area smoke detector, sprinkler system waterflow indicating device, or by any automatic fire suppression system monitored this shall cause the following actions or effects to take place:
 1. At the panel and any remote annunciators, a system alarm LED shall flash and a local sounding device shall activate.
 2. The 80-character LCD display shall indicate all pertinent information associated with the alarm condition and its location.
 3. The digital communicator shall activate and transmit a WATERFLOW ALARM or GENERAL ALARM signal to the monitoring company.
 4. All audible and visual signal devices shall activate and operate until silenced manually, or until automatically silenced, by the control panel. Any subsequent alarm from another device shall automatically reactivate all audible and visual signal devices. Once a waterflow alarm (when applicable) has been activated in shall not be possible to manually silence the audible and visual signal devices until the flow indication from the waterflow switch has ceased.
 5. Fire safety control functions related to providing free egress from the facility shall be activated on general alarm, including the automatic opening of any controlled motorized security grills and automatic unlocking for egress of any controlled non-fire rated security doors or gates.
 6. Fire safety control functions conditional on the detection of an alarm condition in one or more designated adjacent area smoke detectors shall be activated independently on a one-for-one basis, these functions may include air handler shutdown of units without a duct mounted smoke detector, electromagnetic door hold back release, release of

- overhead coiling or hinged fire or smoke rated doors or shutters (those designed to close in order to control the spread of fire or smoke), high volume low speed (HVLS) fan shut down, and any other conditional operations such as elevator recall.
7. Each Fire Safety Control Function circuit controlled device shall be configured such that when the fire alarm system safety control function circuit is re-energized, by the fire alarm control panel, the device shall return to normal operation (e.g. be ready to re-start) without a need for manual or environmental control system intervention.
 8. The FACP event history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
- B. The detection of any system internal or external trouble condition or the actuation of any supervisory alarm condition, as applicable, including any duct mounted smoke detector, sprinkler system valve tamper switch, sprinkler system low pressure switch, et cetera, shall automatically cause the following actions to take place:
1. At the panel and any remote annunciators, a system supervisory alarm LED or trouble LED shall flash as appropriate and a local sounding device shall activate. Audible supervisory or trouble alerts that have been silenced shall automatically resound every twenty-four hours or less until repairs are made.
 2. The 80-character LCD display shall indicate all pertinent information associated with the trouble or supervisory condition and its location; however, unacknowledged alarm messages shall have priority over trouble messages.
 3. The digital communicator shall activate and transmit a SUPERVISORY or TROUBLE signal to the monitoring company.
 4. Detection of a supervisory alarm in a duct mounted smoke detector shall initiate shutdown of the associated air handler, and closing of any smoke dampers or fire/smoke dampers located in that unit's duct system, on a conditional one-for-one basis.

3.7 BASIC SETUP AND TESTING

- A. The completed system is to be tested for compliance with the specifications.
- B. The System Contractor shall make a thorough inspection of the complete installation to ensure the following:
 1. Complete and functional system.
 2. Installed in accordance with manufacturer's instructions.
- C. Prior to the testing, ensure that the system is free of short circuits, ground loops, excessive system noise beyond published specifications of the equipment, hum, RF interference, or instability of any form.
- D. The testing work shall be performed after installation has been completed, but prior to any use of the system.
- E. All audio inputs, including live microphone, automated evacuation messages, temporary testing signal, and any additional low priority inputs such as an intercom/public address, telephone system paging, and background music (if approved by the LAHJ), shall be adjusted and matched to the produce proper effective volume output from the system.
- F. Always operate audio amplifiers and speakers within their specified ratings. Excessive input may distort sound quality and may damage audio equipment. Do not exceed +130% of speaker input voltage per UL 1480. Improper input voltage can damage speaker. If distortion is heard, check for clipping of the audio appliance with an oscilloscope and reduce the amplifier input level or gain level to eliminate any clipping.
- G. Check the installation instructions of the manufacturers of other equipment used in the system for any guidelines or restrictions on wiring and/or locating Voice Notification Appliance Circuits

(Voice NAC) and notification appliances. Some system communication circuits and/or audio circuits, for example, may require special precautions to assure electrical noise immunity (e.g. audio crosstalk).

- H. The system shall be set up for a general occupancy and at no point in the testing or operation of the system shall output be allowed to exceed 95 dB at any occupiable position to prevent possible hearing damage, and system damage. It is prohibited at any time to “ring out” the system by turning it up until it distorts.
- I. The installer shall maximize the gain structure and balance each system component to provide the least possible variation in sound level and frequency response in each area as required. The testing shall be performed with a minimum of the following equipment:
 - 1. Professional 1/3 octave Real Time Analyzer (RTA) and Type One sound pressure level (SPL) meter- Ivie IE-30A or PC-40 with calibrated microphone or equivalent by Crown or White Instruments.
 - 2. Pink Noise Generator – Ivie IE-20B or equivalent by Crown or White Instruments.

3.8 MAXIMIZING GAIN STRUCTURE

- A. Each emergency communication system speaker circuit shall be setup to maximize the gain structure of all components. Gain structure refers to aligning the gain of each device so that they all clip at the same point, and the noise floor of the entire system is at its absolute minimum. This shall be set up by using clip indicators on the amplifiers themselves. If there are no clip indicators on the component, the contractor should use output meters to determine the correct setting.
- B. Adjustments should be made using built in attenuators, unless no adjustment is available or the required level is out of range, then the contractor shall use a temporary level-matching interface to determine the dB value for a fixed audio resistive attenuator made up of two parallel resistors, which shall be permanently installed.
- C. For the first step, disconnect the loudspeakers from the amplifier outputs and replace them with dummy load resistors. Turn the input sensitivity and output level controls on all components all the way down. Turn on the system and supply a continuous pink noise input signal to the mixer. Turn up the output of the mixer until it begins clipping. Once the mixer is just clipping, back the output gain down slightly until the clip indicator turns off.
- D. For the second step run the maximized pink noise signal through the any processors and into the amplifier (with all crossover and output gain setup for each amplifiers channels' particular speaker load). Make sure that the processor output limiters are turned off. Run this signal into the amplifiers and turn up the input attenuators until the amplifier clip indicator begins to turn on. Turn the attenuators down slightly, so the clip indicator no longer is on. This procedure will maximize the gain through the system. This amplifier setting should provide maximum gain without clipping, in other words when the output of the mixer is clipping the amplifiers would also be at the clip point. Once the clip point of each amplifier channel is determined, mark this position.
- E. Third step, once any limiters are set up and the gain is maximized, reduce the main output of the mixer, and reconnect the loudspeakers. Play some familiar music through the system and verify that the output is loud enough with a decibel meter. If the system is not loud enough, verify that all components are operating properly. Then check the amplifier and speaker output ratings to ensure the proper devices were installed in the correct channels. If the setup is too loud for safe operation, turn down and balance all amplifier channel input attenuators for safe balanced operation.

3.9 PERFORMANCE TESTING

- A. After basic setup and testing, the sound system shall meet or exceed the following specifications:
 - 1. System shall be free of short circuits, ground loops, parasitic oscillation, excessive system noise, hum, and instability of any form, including RF interference.
 - 2. Maximum SPL with band-limited pink noise input to the system shall be 95 dB before audible distortion occurs.
- B. Acoustic response of the system shall be plus or minus 1.5 dB along a line which is flat from 100 Hz to 1250 Hz and which rolls off at 2 dB per octave to 8 kHz.

3.10 VOICE INTELLIGIBILITY TESTING

- A. Once the basic setup is complete, the gain structure is maximized, and the performance testing as outlined above is completed, this contractor shall conduct voice intelligibility testing as prescribed in the NFPA 72 and as follows:
 - 1. The building shall be divided into Acoustically Distinguishable Spaces for testing by basic areas of the building and single rooms.
 - 2. Final voice intelligibility testing shall be conducted in accordance with the test instrument manufactures written instructions and during normal hours of operation and under normal building occupancy conditions including all final room finishes, furnishings, and with a nominal number of occupants at their normal activity level, or as near as these conditions can be simulated. Simulation may include taking sample background noise measurements or “captured curves” for each designated ADS with stand in personnel for use in the testing process.
 - 3. From each designated fixed-point test location in each ADS, the technician shall calibrate the test instrument, measure, and record the STI value while the test signal is played through the entire building emergency communication system.
 - 4. Voice intelligibility test results for this emergency communication system will be acceptable if at least 90% of the measurement locations within each ADS has a measured STI of not less than 0.45 (CIS of not less than 0.65), and an average STI of not less than 0.50 (an average CIS of not less than 0.70). The contractor shall make any system adjustments or modifications needed for each ADS to pass the indelibility testing.
 - 5. If an ADS does not meet the above requirements due to low readings, the testing procedures shall be verified, and adjustments made that may include increasing the volume of individual speakers, changing types, or adding additional speakers, or working with the Architect to provide acoustical treatments that will reduce inordinate background noise and/or reverberation.
 - 6. The final acceptance of the system by the Owner/Architect/Engineer will be based upon the proper performance of the completed system.

3.11 TESTING, WARRANTY, SERVICE

- A. A factory-trained representative of the manufacturer shall supervise the final connections and testing of the system and it shall be subject to the final acceptance of the Architect, Engineer, and local authorities. Testing shall include, but not be limited to, the following:
 - 1. Before energizing the system check all cables for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system valve with a tamper switch, when applicable, and verify proper supervisory alarm at the FACP.
 - 3. Verify alarm activation of waterflow switches by operation of the test port valve on each riser (when applicable).
 - 4. Open each initiating device circuit and verify that the trouble signal actuates.
 - 5. Open and short each signaling line circuit and verify that the trouble signal actuates.
 - 6. Open and short each notification appliance circuit and verify that trouble signal actuates.

7. Individually ground each circuit and verify response of trouble signals.
 8. Check for presence of strobe signal and audibility of tone at all alarm notification devices.
 9. Check installation, supervision, and operation of all area detectors using the walk test.
 10. Check installation, configuration, and operation of all duct mounted smoke detectors. Verify that there is adequate airflow through the sample tubes and housing to activate the detector when smoke is present in the duct.
 11. 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.
 12. Verify proper operation of all fire safety control functions including when applicable fire door hold open/release, coiling fire door release, air handler shutdown, smoke damper or fire/smoke damper control, high volume low speed (HVLS) fan shut down, and the automatic opening of any controlled motorized security grills and automatic unlocking for egress of any controlled non-fire rated security doors or gates.
 13. Check operation of elevator recall and shunt-trip when applicable.
 14. Ensure that all dust covers are removed from smoke and heat detectors at substantial completion.
- B. The Fire Alarm Contractor shall be ultimately responsible for safe and complete operation of the system. Any issues affecting proper operation of the system relating to the Electrical, Mechanical, Fire Protection, Fire Suppression or other contractors shall be resolved by the Fire Alarm Contractor, at no additional cost to, and without requesting intervention by the Owner.
- C. For all fire alarm systems that are modified after initial installation the Fire Alarm Contractor shall revise the original record of completion to show all changes from the original information and indicate a revision date.
- D. The contractor shall provide a warranty of all newly installed system devices and cabling against defects in material or workmanship for a period of one (1) year from the date of substantial completion. Any new equipment or cabling shown to be defective shall be replaced, repaired, or adjusted free of charge. All labor and materials shall be provided at no expense to the Owner. All new equipment will carry a one-year warranty or manufacturers warranty whichever is greater.

3.12 DRAWINGS, MANUALS, AND TRAINING

- A. As-built drawings and operating and maintenance manuals may be electronically transmitted in PDF file format (preferred) or paper copies may be provided in quantities indicated in Division 1. Paper copies shall be organized including index tabs in a 3-ring black binder of sufficient size.
- B. Upon completion of the installation, and prior to final inspection, the fire alarm Contractor shall furnish as-built drawings.
- C. In addition, the fire alarm contractor shall furnish complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets. Manuals shall include wiring diagrams to indicate internal wiring for each device and the interconnections between the items of equipment. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system. Provide a parts list with manufacturer and model number for commonly replaced parts. Include complete instructions for the inspection, testing, and maintenance of the system.
- D. Provide the Owner a copy of the panel control software including the licensed program, site specific data file, and passwords that the Owner may require to maintain the system.

- E. The fire alarm contractor shall conduct formal on-site training sessions. It shall be the responsibility of the Contractor to coordinate time and location of training sessions with the Owner. Provide documented general instruction as follows:
1. Provide instruction to the maintenance personnel to include the location, inspection, maintenance, testing, and operation of all system components. Provide a minimum of four (4) hours-two 2-hour sessions separated by a minimum of two weeks.
 2. Provide instruction to designated personnel on the functions and operation of the FIRE DETECTION AND ALARM SYSTEM including capabilities, limitations, monitoring, and the meaning of status messages. State the proper procedure for fire drills, routine maintenance, and request for service. Provide a minimum of four (4) hours-two 2-hour sessions separated by a minimum of two weeks.

END OF SECTION

SECTION 31 0516

AGGREGATES FOR EARTHWORK

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Aggregate materials for use as specified in other Sections.

1.2 RELATED SECTIONS

- A. Section 02 4113 – Site Demolition
- B. Section 31 1000 - Site Clearing
- C. Section 31 2300 - Excavation and Fill
- D. Section 31 3200 - Soil Stabilization
- E. Section 31 2500 - Erosion and Sedimentation Control
- F. Construction Drawings
- G. Storm Water Pollution Prevention Plan (SWPPP)

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
 - 1. C136 Method for Sieve Analysis of Fine and Coarse Aggregates
 - 2. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN.m/m³))
 - 3. D 1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN.m/m³))
 - 4. D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
 - 5. D 2487 Classification of Soils for Engineering Purposes
 - 6. D 2922 Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
 - 7. D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 8. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - 1. T 88 Particle Size Analysis of Soils
- C. State Department of Transportation (DOT): Standard Specifications for Construction and Materials, Latest Edition.
- D. North Central Texas Council of Governments (NCTCOG) Public Works Construction Standards latest edition

1.4 QUALITY ASSURANCE

- A. Tests and analysis of aggregate materials will be performed in accordance with ASTM and AASHTO procedures specified herein.

1.5 SUBMITTALS

- A. Submit 30-pound sample of each aggregate or mixture that is to be incorporated into project in air-tight containers to the independent testing laboratory or submit gradation and certification of aggregate material that is to be incorporated into project to the independent testing laboratory for review.
- B. Submit name of each material supplier and specific type and source of each material. Any change in source requires approval of Owner.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Construction and materials shall meet or exceed requirements of this Section and applicable state highway department specifications section(s) referred to or noted on the Construction Drawings which pertain to paving base course design, materials, preparation, and execution. Materials shall be as indicated in the Construction Documents and shall comply with state highway department specifications regarding source, quality, gradation, soundness, absorption, liquid limit, plasticity index, and mix proportioning.
- B. Soil Materials
 - 1. Class II: Coarse-Grained Soils; conforming to ASTM D2487 Group Symbol, GW, GP, SW and SP.
 - 2. Class III: Coarse-Grained Soils with Fines; conforming to ASTM D2487 Symbol GM, GC, SM and SC.
 - 3. Class IV-A: Fine-Grained Soils (inorganic); conforming to ASTM D2487 Group Symbol ML and CL.
 - 4. Class IV-B: Fine Grained Soils (inorganic); conforming to ASTM D2487 Group Symbol MH and CH.
 - 5. Class V: Organic Soils; conforming to ASTM D2487 Group Symbol OL, OH, and PT.
- C. Aggregate Material
 - 1. Coarse Aggregate Coarse A1: Material shall be sound crushed limestone, crushed slag, granulated slag, crushed gravel, or other types of suitable material meeting the requirements of this section. Crushed limestone, crushed slag and crushed gravel shall meet the following grading requirements:

COARSE A-1	
Sieve Size	Percent Passing
1-1/2 inches	100
1 inch	75-100
3/4 inch	60-100
3/8 inch	35-75
No. 4	30-60
No. 30	7-30
No. 200	0-5

2. Coarse Aggregate Coarse A2: Material shall be crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the requirements of this item. Crushed carbonate stone or mixtures of crushed and granulated slags shall meet the following gradation requirements:

COARSE A-2	
Sieve Size	Percent Passing
2 inches	100
1 inch	70-100
¾ inch	50-90
No. 4	30-60
No. 30	7-30
No. 200	0-5

3. Aggregate Type A3: Pea Gravel – Natural stone; washed, free of clay, shale, organic matter; graded in accordance with ASTM C136 and D2487; to the following limits:

- a. Minimum size: 1/4 inch
- b. Maximum Size: 5/8 inch

4. Fine Aggregate Type A4: Sand – Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM C136 and D2487; within the following limits:

COARSE A-4	
Sieve Size	Percent Passing
No. 4	90-100
No. 30	7-40
No. 200	0-5

5. Class I-A: Material shall be sound crushed limestone, crushed slag, granulated slag, crushed gravel, or other types of suitable material meeting the requirements of this item. Crushed limestone, crushed slag and crushed gravel shall meet the following grading requirements:

Sieve Size	Percent Passing
1-1/2 inches	100
No. 4	<10
No. 200	<5

6. Class I-B: Material shall be crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the requirements of this item. Crushed carbonate stone or mixtures of crushed and granulated slags shall meet the following gradation requirements:

Sieve Size	Percent Passing
1-1/2 inches	100
No. 4	<50
No. 200	<5

2.2 EQUIPMENT

- D. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger any improvements by rutting, overloading, or pumping.

PART 3 EXECUTION

3.1 STOCKPILING

- A. Stockpile on-site at locations indicated by Owner in such manner that there will be no standing water or mixing with other materials.
- B. Conform to the requirements of the SWPPP re: stockpiling on site.

3.2 BORROW AND SPOIL SITES

- A. Upon completion of borrow and/or spoil operations, clean up borrow and/or spoil areas as indicated on Construction Drawings in neat and reasonable manner to satisfaction of property owner and Owner.

END OF SECTION

SECTION 31 1000

SITE CLEARING

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists. Prior to any work on the site including site clearing, dial 811 to call out utility locating company. Wait for utilities to be marked prior to start of work. "Call before you dig."

1.1 SECTION INCLUDES

- A. Clearing site of debris, grass, trees, and other plant life in preparation for site or building earthwork.
- B. Protection of existing structures, trees, or vegetation indicated on the Construction Drawings to remain.
- C. Stripping topsoil from areas that are to be incorporated into limits of project and storage of topsoil where so indicated on Construction Drawings.

1.2 RELATED SECTIONS (but not limited to):

- A. Section 02 4113 – Site Demolition
- B. Section 31 2300 – Excavation and Fill
- C. Section 32 9343 – Tree Protection and Removal
- D. Storm Water Pollution Prevention Plan (SWPPP)
- E. Construction Drawings

1.3 ENVIRONMENTAL REQUIREMENTS

- A. Construct temporary erosion control systems as shown on Construction Drawings or as directed by the "Storm Water Pollution Prevention Plan" (SWPPP) to protect adjacent properties and water resources from erosion and sedimentation.
- B. In the event that sitework on this project will disturb 1 or more acres; Contractor shall not begin construction without "Texas Pollution Discharge Elimination System" (TPDES) permit governing discharge of storm water from the site for the entire construction period. TPDES permit requires SWPPP to be in place during construction. Contractor shall be responsible for SWPPP and maintaining it as a living document during construction.
- C. Contractor shall be totally responsible for conducting storm water management practices in accordance with the TPDES permit and for consequences of enforcement action taken or imposed by Federal or State agencies, including cost of fines, construction delays, and remedial actions resulting from Contractor's failure to comply with provisions of TPDES permit.
- D. In some states beginning August 1, 2011, for construction sites over 20 acres, contractor shall be required to comply with effluent limit guidelines requiring all sites to sample stormwater discharges and comply with numeric effluent limitations (NEL) of 280 nephelometric turbidity units (NTU). Note: Texas General Permit expires March 5, 2013. At that point it may be modified to sample stormwater.

1.4 PROJECT CONDITIONS

- A. Existing Conditions at time of inspection for bidding purposes will be maintained by Owner in so far as practical.
- B. Contractor shall visit the site and verify the nature and extent of clearing work required.
- C. Variations to conditions or discrepancy in actual conditions as they apply to site preparation operations are to be brought to attention of Owner prior to commencement of sitework.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. Off-site materials shall be transported to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

PART 3 EXECUTION

3.1 PREPARATION

- A. Identify existing plant life that is to remain and verify that clearing limits are clearly tagged, identified, and marked in such manner as to ensure their safety throughout construction operations.

3.2 PROTECTION

- A. Locate and identify existing utilities that are to remain and protect these from damage.
- B. Protect trees, plant growth, and features designated to remain as part of final landscaping in accordance with Section 32 9343 – Tree Protection and Removal.
- C. Conduct operations with minimum interference to public or private accesses and facilities. Maintain a construction exit as described in the SWPPP to minimize tracking of sediment onto adjacent public and private roadways. Maintain ingress and egress at all times and clean or sweep roadways daily as required by SWPPP or governing authority. Dust control shall be provided with sprinkling systems or equipment provided by Contractor.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, in kind with a monument identifying the licensed land surveyor making replacement.
- E. Provide traffic control as required, in accordance with the US Department of Transportation's "Manual on Uniform Traffic Control Devices" and applicable state DOT requirements.

3.3 CLEARING

- A. Clear areas required for access to site and execution of work.
- B. Unless otherwise indicated on Construction Drawings, remove trees, shrubs, grass, other vegetation, improvements, or obstructions interfering with installation of new construction. Removal includes digging out stumps and roots. Depressions caused by clearing and grubbing operations are to be filled and compacted in accordance with the recommendations of the site Geotechnical Engineer to avoid ponding of water. Satisfactory fill material shall be placed in accordance with Section 31 2300.
- C. Remove grass, trees, plant life, stumps, and other construction debris from site to dump site that is suitable for handling such material according to state laws and regulations.

- D. Conform to requirements of SWPPP regarding disposal offsite.

3.4 TOPSOIL EXCAVATION

- A. Topsoil shall consist of organic surficial soil found in depth of not less than 6-inches. Satisfactory topsoil shall be reasonably free of subsoil, clay lumps, stones and other objects over 2-inches in diameter, weeds, roots, and other objectionable material.
- B. Cut heavy growths of grass from areas before stripping and remove cuttings with remainder of cleared vegetative material.
- C. Strip topsoil from areas that are to be filled, excavated, landscaped, or re-graded to such depth that it prevents intermingling with underlying subsoil or questionable material.
- D. Stockpile topsoil in storage piles in areas shown on Construction Drawings or where directed by Owner. Construct storage piles to freely drain surface water. Cover storage piles as required to prevent windblown dust. Dispose of unsuitable topsoil as specified for waste material, unless otherwise specified by Owner. Contractor shall remove excess topsoil from site unless specifically noted otherwise on Construction Drawings.
- E. Conform to requirements of SWPPP regarding stockpiling topsoil onsite

END OF SECTION

SECTION 31 2300

EXCAVATION AND FILL

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists. Prior to any work on the site including excavation and fill, dial 811 to call out utility locating company. Wait for utilities to be marked prior to start of work. "Call before you dig."

1.1 SECTION INCLUDES

- A. Installation of site work with particular attention to grade changes and necessary staging or phasing of work.
- B. Cutting, over excavating, filling, and grading to required lines, dimensions, contours, and elevations for proposed improvements.
- C. Scarifying, compacting, drying, dewatering and removal of unsuitable material to ensure proper preparation of areas for fills or proposed improvements.

1.2 RELATED SECTIONS

- A. Section 02 4113 – Site Demolition
- B. Section 31 1000 - Site Clearing
- C. Section 31 2318 - Rock Excavation
- D. Section 31 3200 - Soil Stabilization
- E. Section 31 2500 - Erosion and Sedimentation Control
- F. Section 31 0516 - Aggregate for Earthwork
- G. Section 32 9000 – Planting
- H. Storm Water Pollution Prevention Plan (SWPPP)
- I. The Geotechnical Report for the site and/or the Structural drawings, whichever is more stringent if a conflict exists.
- J. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
 - 1. D 422 Standard Test Method For Particle – Size Analysis of Soil
 - 2. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN.m/m³))
 - 3. D 1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 Kn.m/m³))
 - 4. D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
 - 5. D 2487 Classification of Soils for Engineering Purposes

- 6. D 2922 Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
- 7. D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
- 8. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - 1. AASHTO T 88 Particle Size Analysis of Soils
- C. State Department of Transportation (DOT): Standard Specifications for Construction and Materials, Latest Edition

1.4 QUALITY ASSURANCE

- A. An independent testing laboratory will be retained to perform construction testing on site.
 - 1. The independent testing laboratory shall prepare test reports that indicate test location, elevation data, and test results. Owner, Engineer, and Contractor shall be provided with copies of reports within 96 hours of time that test was performed. In event that test performed fails to meet Specifications, the independent testing laboratory shall notify Owner and Contractor immediately.
 - 2. Costs related to retesting due to failures shall be paid for by Contractor at no additional expense to Owner. Contractor shall provide free access to site for testing activities.

1.5 SUBMITTALS

- A. Submit 30-pound sample of each type of off-site fill material that is to be used at the site in airtight container(s) for the independent testing laboratory or submit gradation and certification of aggregate material that is to be used at the site to the independent testing laboratory for review.
- B. Submit name of each material supplier and specific type and source of each material. Change in source throughout project requires approval of Owner.
- C. If fabrics or geogrids are to be used, design shall be submitted for approval to Engineer.
- D. Submit Dewatering Plans upon request by Owner.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Excavated and re-used material for subsoil fill as specified herein.
- B. Aggregate fill as specified in Section 31 0516.
- C. Imported fill material approved by Owner and specified herein.
- D. Topsoil fill as specified in Section 32 9000.
- E. Acceptable stabilization fabrics and geogrids as specified in Section 31 3200.
- F. Filter and drainage fabrics as specified in Section 31 3200.

2.2 EQUIPMENT

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping. Maintain a construction exit as described in the SWPPP to minimize tracking of sediment onto adjacent public and private roadways.

2.3 SOURCE QUALITY CONTROL

- A. In areas to receive pavement, California Bearing Ratio (CBR) or Limerock Bearing Ratio (LBR) test shall be performed for each type of material that is imported from off-site.
- B. Following tests shall be performed as part of construction testing requirements on each type of on-site or imported soil material used as compacted fill:
 - 1. Moisture and Density Relationship: ASTM D 698
 - 2. Mechanical Analysis: AASHTO T 88
 - 3. Plasticity Index: ASTM D 4318

PART 3 PRODUCTS

3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Locate and identify existing utilities that are to remain and protect from damage.
- C. Notify utility companies to remove or relocate public utilities that are in conflict with proposed improvements.
- D. Protect plant life, lawns, fences, existing structures, previously installed utilities, sidewalks, paving, and curbs.
- E. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- F. Remove from site, material encountered in grading operations that, in the opinion of Owner or Agent, is unsuitable or undesirable for backfilling, subgrade, or foundation purposes. Dispose of said material in manner satisfactory to Owner. Backfill areas with layers of suitable material and compact as specified herein.
- G. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform the following procedures:
 - 1. Confirm in writing whether or not further work within the existing low area, creek, pond, or lake will require a wetlands determination or Section 404 US Army Corps of Engineers Permit.
 - 2. Drain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain the same results.
 - 3. After drainage of low area is complete, remove muck, mud, debris, and other unsuitable material by using acceptable equipment and methods that will keep natural soils underlying low area dry and undisturbed.

4. All muck, mud, and other materials removed from low areas shall be dried on-site by spreading in thin layers completely free of vegetation of any kind for observation by Owner or Agent. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under building subgrade or within 10'-0" of perimeter of building subgrade or paving subgrade. If, after observation by Owner or Agent, material is found to be unsuitable, then unsuitable material shall be removed from site.

H. Dewatering:

1. General:

- a. Design and provide a dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom and/or sides. Design the system to prevent differential hydrostatic head, which would result in floating out soil particles in a manner, termed as a "quick" or "boiling" condition. System shall not be dependent solely upon sumps and/or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation's stability.
- b. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow all Work to be installed in a dry condition.
- c. Control, by acceptable means, all water regardless of source. The Contractor is fully responsible for disposal of the water. Disposal of water from dewatering operations is a highly regulated construction operation. On this project the contractor is totally responsible for obtaining and complying with all required permits prior to proceeding with dewatering.
- d. Confine discharge piping and/or ditches to available easement or to additional easement obtained by Contractor. Provide necessary permits and/or additional easement at no additional cost to Owner.
- e. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary to these purposes, lower water level in advance of excavation, utilizing wells, wellpoints, jet ejector, or similar positive methods. The water level as measured by piezometers shall be maintained a minimum of 3 feet below prevailing excavation level.
- f. Commence dewatering prior to any appearance of water in excavation and continue until Work is complete to the extent that no damage results from hydrostatic pressure, flotation, or other causes.
- g. Open pumping with sumps and ditches shall be allowed, provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes.
- h. Install wells and/or wellpoints, if required, with suitable screens and filters, so that continuous pumping of fines does not occur. Arrange discharge to facilitate collection of samples by the Owner. During normal pumping, and upon development of well(s), levels of fine sand or silt in the discharge water shall not exceed 5 ppm. Install sand tester on discharge of each pump during testing to verify that levels are not exceeded.
- i. Control grading around excavations to prevent surface water from flowing into excavation areas.

- j. No additional payment will be made for any supplemental measures to control seepage, groundwater, or artesian head.
2. Design:
- a. Contractor shall designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work.
 - b. Contractor shall be responsible for the accuracy of the drawings, design data, and operational records required.
 - c. Contractor shall be solely responsible for the design, installation, operation, maintenance, and any failure of any component of the system.
3. Damages:
- a. Contractor shall be responsible for and shall repair without cost to the Owner any damage to work in place, or other contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation. Contractor shall also be exclusively responsible for damage to the bottom due to heave including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.
 - b. Remove subgrade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to the Owner.
4. Maintaining Excavation in Dewatering Condition:
- a. Dewatering shall be a continuous operation. Interruptions due to power outages, or any other reason will not be permitted.
 - b. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction and/or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.
 - c. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to Owner.
 - d. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain excavation in dewatered condition.
5. System Removal:
- a. Remove dewatering equipment from the site, including related temporary electrical service.

- b. Wells shall be removed or cut off a minimum of 3-feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction.

3.2 EXCAVATION FOR FILLING AND GRADING

- A. Classification of Excavation: by submitting bid, Contractor acknowledges that site has been investigated to determine type, quantity, quality, and character of excavation work to be performed. Excavation shall be considered unclassified excavation, except as indicated in the Contract Documents.
- B. When performing grading operations during periods of wet weather, provide adequate dewatering, drainage and ground water management to control moisture of soils.
- C. Shore, brace, and drain excavations as necessary to maintain excavation as safe, secure, and free of water at all times.
- D. Excavated material containing rock or stone greater than 6-inches in largest dimension is unacceptable as fill within proposed building subgrade and paving subgrade.
- E. Excavated material containing dirt clods greater than 8-inches in largest dimension is unacceptable as fill. Clods and chunks of materials should be broken and the fill material mixed by disking, blading, or plowing, as necessary, so that a material of uniform moisture and density is obtained for each lift.
- F. Rock or stone less than 4-inches in largest dimension is acceptable as fill to within 24-inches of surface of proposed subgrade when mixed with suitable material.
- G. Rock or stone less than 2-inches in largest dimension and mixed with suitable material is acceptable as fill within the upper 24-inches of proposed subgrade.

3.3 FILLING AND SUBGRADE PREPARATION

- A. Fill areas to contours and elevations shown on Construction Drawings.
- B. Place fills in continuous lifts specified herein.
- C. Refer to Related sections for building pad preparation for structures.
- D. Refer to Section 31 3200 for soil stabilization using lime, cement, fly ash, and geotextile fabrics.
- E. Refer to Section 31 2318 for rock excavation.
- F. Areas exposed by excavation or stripping and on which subgrade preparations for paving are to be performed, including future pavement areas, shall be scarified to minimum depth of 8-inches and compacted to not less than 98 percent of maximum density, in accordance with ASTM D 698 at moisture content of not less than 1 percent below and not more than 3 percent above optimum moisture content. Proofroll these areas to detect areas of insufficient compaction. Accomplish proofrolling by making minimum of 2 complete passes with fully-loaded tandem-axle dump truck with a maximum loaded weight of 20-tons, or approved equal, in each of 2 perpendicular directions until acceptable. Excavate and recompact areas of failure as specified herein. Continual failure areas shall be stabilized in accordance with Section 31 3200 at no additional cost to Owner.
- G. Place fill materials used in preparation of the subgrade in loose horizontal lifts not to exceed 8-inches in uncompacted thickness and compacted to minimum density of not less than 98 percent of maximum density, in accordance with ASTM D 698, at moisture content of not less than 1 percent below and not more than 3 percent above optimum moisture content. The fill material should be uniform with respect to material type and moisture content. Clods and chunks of materials should be broken down to 8" diameter or less and the fill material mixed

by disking, blading, or plowing, as necessary, so that a material of uniform moisture and density is obtained for each lift. Water required to bring the fill material to the proper moisture content should be applied evenly through each layer

- H. Following table stipulates maximum allowable values for plasticity index (PI) and liquid limit (LL) of suitable fill materials to be used in specified areas, unless specifically stated otherwise on Construction Drawings:

Location	PI	LL
Building area, below upper four feet *	20	50
Building area, upper four feet *	12	40
Site Area, below upper two feet *	20	50
Site Area, upper two feet *	15	40
Paving Area, below upper two feet *	20	50
Paving Area, upper two feet *	15	40

(*References to depth are to proposed subgrade elevations)

3.4 MAINTENANCE OF SUBGRADE

- A. Verify finished subgrades to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks, dump trucks, and other construction equipment.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material with CBR or LBR equal to or better than that specified on the construction documents/drawings. Surface of subgrade after compaction shall be firm, uniform, smooth, stable, and true to grade and cross-section.
- D. Construct temporary ditches and/or perform such grading as necessary to maintain positive drainage away from subgrade at all times.

3.5 BORROW AND SPOIL SITES

- A. Contractor shall be responsible for compliance with TPDES and local erosion control permitting requirements for any and all on-site and off-site, disturbed spoil and borrow areas. Upon completion of spoil and/or borrow operations, clean up spoil and/or borrow areas in a neat and reasonable manner to the satisfaction of off-site property owner, if applicable, and Owner.

3.6 RIP-RAP

- A. Place rip-rap in areas where indicated on Construction Drawings. Stone for rip-rap shall consist of field stone or rough unhewn quarry stone as nearly uniform in section as is practical. Stones shall be dense, resistant to action of air and water, and suitable for purpose intended. Unless otherwise specified, stones used as rip-rap shall weigh between 50-pounds and 250-pounds each, and at least 60 percent of stones shall weigh more than 100-pounds each.
- B. Dress slopes and other areas to be protected to line and grade shown on Construction Drawings prior to placing of rip-rap. Undercut areas to receive rip-rap to elevation equal to final elevation less average diameter of stones before placing rip-rap.

- C. Install filter fabric and bedding stone prior to placement of stones. Bedding stone shall be quarried and crushed angular limestone, 6-inches in depth in accordance with Section 31 0516 and with the following gradation:

Bedding Stone	
Sieve Designation	% By Weight Passing Square Mesh Sieves
3"	100
No. 4	20-65
No. 200	0-10

Filter fabric shall be as specified in Section 31 3200 and as detailed on Construction Drawings.

- D. Place stones so that greater portion of weight is carried by earth and not by adjacent stones. Place stones in single layer with close joints. Upright areas of stone shall make angle of approximately 90 degrees with embankment slope. Place courses from bottom of embankment upward, with larger stones being placed in lower courses. Fill open joints with spalls. Embed stones in embankment as necessary to present uniform top surface such that variation between tops of adjacent stones shall not exceed 3-inches.
- E. If plans call for grouting of stones, ensure that 1/2 the nominal depth of the stones is exposed and without grout so as to promote energy dissipation for drainage applications. Grout for rip rap shall consist of a flowable concrete with a minimum strength of 2000 psi at 28 days.

3.7 FINISH GRADING

- A. Grade areas where finish grade elevations or contours are indicated on Construction Drawings, other than paved areas and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Finished subgrade surface for structures shall not be more than 0.10 foot above or below established finished subgrade elevation measured on a 10' by 10' grid. Ground surfaces shall vary uniformly between indicated elevations. Verify site grades at 50' x 50' grids. Grade finished ditches to allow for proper drainage without ponding and in manner that will minimize erosion potential. For topsoil, sodding and seeding requirements refer to Section 32 9000.
- B. Correct settled and eroded areas within 1 year after date of completion at no additional expense to Owner. Bring grades to proper elevation. Replant or replace grass, shrubs, bushes, or other vegetation that appears dead, dying, or disturbed by construction activities.

3.8 FIELD QUALITY CONTROL

- A. Field density tests for in-place materials shall be performed as part of construction testing requirements according to the Nuclear Method ASTM D 2922 and as follows:
1. Building Subgrade Areas, including 10'-0" outside of exterior building lines: In cut areas, not less than 1 compaction test for every 2,500 sq. ft. In fill areas, same rate of testing for each 8-inch lift, measured loose.
 2. Areas of construction exclusive of building subgrade areas: In cut areas, not less than 1 compaction test for every 10,000 sq. ft. In fill areas, same rate of testing for each 8-inch lift, measured loose.
 3. For trenches, one test at intervals not exceeding 75 feet of trench length for each 8-inch lift, measured loose.
- B. Corrective measures for non-complying compaction:
1. Remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner. Adjust moisture content as necessary to conform to the requirements of this section.

END OF SECTION

EXCAVATION AND FILL
31 2300 -8

SECTION 31 2310
BUILDING EXCAVATION AND FILL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Work included: Excavate, backfill, compact, and grade for the building to the elevations shown on the Drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.
- B. Related work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 00 3132 – Geotechnical Data.
 - 3. Section 01 4000 – Quality Requirements.

1.02 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.
- C. In addition to complying with requirements of governmental agencies have jurisdiction, comply with the directions of the Geotechnical Engineer.

1.03 PRODUCT HANDLING

- A. Comply with pertinent provisions of Supplementary Conditions.

PART 2 – PRODUCTS

2.01 SOIL MATERIALS

- A. Provide fill as indicated on the Drawing Sheets prepared by the various design professionals on the project.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the area and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 FINISH ELEVATIONS AND LINES

- A. Finish grades shall be as shown on the site plan and shall form straight lines of slope between elevation markings.

3.03 PROCEDURES

- A. Utilities:
 - 1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.
 - 2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
 - 3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
 - 4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Architect and secure his instructions.

5. Do not proceed with permanent relocation of utilities until written instructions are received from the Architect.
- B. Protection of persons and property:
 1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.
 2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
 3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.
- C. De-watering:
 1. Remove all water, including rain water, encountered during trench and sub-structure work to an approved location by pumps, drains, and other approved methods.
 2. Keep excavations and site construction area free from water.
 3. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.
- D. Maintain access to adjacent areas at all times.

3.04 EXCAVATING

- A. Perform excavating of every type of material encountered within the limits of the Work to the lines, grades, and elevations indicated and specified herein.
- B. Surplus material:
 1. Dispose of unsatisfactory excavated material, and surplus satisfactory excavated material, away from the Project site.
- C. Unauthorized excavation:
 1. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific instruction from the Architect or the Geotechnical Engineer.
 2. Under footings, foundations, or retaining walls:
 - a. Fill unauthorized excavations by extending the indicated bottom elevation of the footing or base to the excavation bottom, without altering the required top elevation.
 - b. When acceptable to the Geotechnical Engineer, lean concrete fill may be used to bring the bottom elevation to proper position.
 3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations, unless otherwise directed by the Geotechnical Engineer.
- D. Stability of excavations:
 1. Slope sides of excavations to 1:1 or flatter, unless otherwise directed by the Geotechnical Engineer.
 2. Shore and brace where sloping is not possible because of space restrictions or stability of the materials being excavated.
 3. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
- E. Shoring and bracing:
 1. Provide materials for shoring and bracing as may be necessary for safety of personnel, protection of work, and compliance with requirements of governmental agencies having jurisdiction.
 2. Maintain shoring and bracing in excavations regardless of the time period excavations will be open.
 3. Carry shoring and bracing down as excavation progresses.
- F. Excavating for structures:
 1. Conform to elevations and dimensions shown within a tolerance of 0.10 ft., and extending a sufficient distance from footings and foundations to permit placing and removing concrete formwork, installation of services, other construction required, and for inspection.
 2. In excavating for footings and foundations, take care not to disturb bottom of excavation:

- a. Excavate by hand tools to final grade just before concrete is placed.
 - b. Trim bottoms to required lines and grades to leave solid base to receive concrete.
 - c. Where continuous or spot footings are shown to be bearing on the soil, compact the bottom of the footing as noted in Paragraph 3.06 of this Section. Trenches and foundation holes shall be dry and free of water when concrete is placed.
3. Excavate for footings and foundations only after general site excavating, filling, and grading are complete.

3.05 FILLING AND BACKFILLING

- A. General:
 1. For each classification listed below, place acceptable soil material in layers to required sub-grade elevations. Provide fill and backfill as indicated on the Drawing Sheets prepared by the various design professionals on the project.
- B. Backfill excavations as promptly as progress of the Work permits, but not until completion of the following.
 1. Acceptance of construction below finish grade including, where applicable, dampproofing and waterproofing.
 2. Inspecting, testing, approving, and recording locations of underground utilities.
 3. Removing concrete formwork.
 4. Removing shoring and bracing, and backfilling of voids with satisfactory materials.
 5. Removing trash and debris.
 6. Placement of horizontal bracing on horizontally supported walls.
- C. Placing and compacting:
 1. Place backfill and fill materials in layers not more than 8" in loose depth.
 2. Before compacting, moisten or aerate each layer as necessary to provide the optimum moisture content.
 3. Compact each layer to required percentage of maximum density for area.
 4. Do not place backfill or fill material on surfaces that are muddy, frozen, or containing frost or ice.
 5. Place backfill and fill materials evenly adjacent to structures, to required elevations.
 6. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.
 7. Where the construction includes basement or other underground walls having structural floors over them, do not backfill such walls until the structural floors are in place and have attained sufficient strength to support the walls.

3.06 COMPACTING

- A. Compact the soil within the building lines as indicated in the Structural drawings and the geotechnical report. If there are any discrepancies, the Contractor shall compact to the most stringent case of these.
- B. Control soil compaction during construction outside building lines to provide the minimum percentage of density specified for each area as determined according to ASTM D698 Standard Proctor Density.

3.07 FIELD QUALITY CONTROL

- A. An Special Inspection and Testing Agency (SITA) will perform field quality control tests and inspections, as specified in Section 01 4533.

3.08 MAINTENANCE

- A. Protect newly graded areas.
- B. Where 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.

PART 4 – TRENCHING REQUIREMENTS

4.01 GENERAL

- A. These requirements shall be used for all trench excavations deeper than five (5) feet. The excavating and trenching operation manual of OSHA, Subpart B (latest edition) shall be the minimum governing requirement of this item and is hereby made a part of this specification.
1. Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to Table P-1 as a guide sloping of banks. Trenches less than 5 feet in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.
 2. Sides of trenches in unstable or soft material, 5 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them. See Table P-1, P-2 (following paragraph (I) of this section.)
 3. Sides of trenches in hard or compact soil, including embankments, shall be shored or otherwise supported when the trench is more than 5 feet in depth and 8 feet or more in length. In lieu of shoring, the sides of the trench above the 5-foot level may be sloped to preclude collapse, but shall not be steeper than a 1-foot rise to each 1/2-foot horizontal. When the outside diameter of a pipe is greater than 6 feet, a bench of 4-foot minimum shall be provided at the toe of the sloped portion.
 4. Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.
 5. Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.
 6. Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.
 7. Minimum requirements for trench timbering shall be in accordance with Table P-2.
 8. Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stress in excess of values given by the following formula:
 - a. $S=3-20L/D$
 - b. Maximum ratio $L/D=50$
 - c. Where: L = Length, unsupported, in inches.
 - d. D = Least side of the timber in inches.
 - e. S = Allowable stress in pounds per square inch of cross-section.
 9. When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps shall be provided and located so as to require no more than 25 feet of lateral travel.
 10. Bracing or shoring of trenches shall be carried along with the excavation.
 11. Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling, or kickouts.
 12. Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench.

13. Backfilling and removal of trench supports shall progress together from the bottom of the trench.
 14. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.
- B. Definitions applicable to this subpart:
1. "Accepted engineering requirements (or practices)" - Those requirements or practices which are compatible with standards required by a registered architect, a registered professional engineer, or other duly licensed or recognized authority.
 2. "Angle of repose" - The greatest angle above the horizontal plane at which a material will lie without sliding.
 3. "Bank" - A mass of soil rising above a digging level.
 4. "Belled excavation" - A part of a shaft or footing excavation, usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.
 5. "Braces (trench)" - The horizontal members of the shoring system whose ends bear against the uprights or stringers.
 6. "Excavation" - Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench.
 7. "Faces" - See paragraph (k) of this section.
 8. "Hard compact soil" - All earth materials not classified as running or unstable.
 9. "Kickouts" - Accidental release or failure of a shore or brace.
 10. "Sheet pile" - A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.
 11. "Sides", "Walls", or "Faces" - The vertical or inclined earth surfaces formed as a result of excavation work.
 12. "Slope" - The angle with the horizontal at which a particular earth material will stand indefinitely without movement.
 13. "Stringers" (wales) - The horizontal members of a shoring system whose sides bear against the uprights or earth.
 14. "Trench" - A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.
 15. "Trench jack" - Screw or hydraulic type jacks used as cross bracing in a trench shoring system.
 16. "Trench shield" - A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.
 17. "Unstable soil" - Earth material, other than running, that because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.
 18. "Uprights" - The vertical members of a shoring system.
 19. "Wales" - See paragraph (m) of this section.
 20. "Walls" - See paragraph (k) of this section.

END OF SECTION

SECTION 31 2316

TRENCHING AND BACKFILL

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Excavation of trenches for installation of utilities.
- B. Backfilling trenches with bedding material as specified and filling trenches with suitable material to proposed subgrade.
- C. Compacting backfill materials in acceptable manner.
- D. Borings and casings under roads.

1.2 RELATED SECTIONS

- A. Section 31 2300 – Excavation and Fill
- B. Section 33 1100 - Water Distribution Systems
- C. Section 33 3100 - Sanitary Sewer Systems
- D. Section 33 3913 - Sewer Manholes, Frames, and Covers
- E. Section 33 5100 - Natural Gas Distribution
- F. Section 33 4000 - Storm Drainage
- G. Section 31 0516 – Aggregates for Earthwork
- H. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
 - 1. D422 Standard Test Method For Particle – Size Analysis of Soil
 - 2. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN.m/m³))
 - 3. D 1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 Kn.m/m³))
 - 4. D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
 - 5. D 2487 Classification of Soils for Engineering Purposes
 - 6. D 2922 Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
 - 7. D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 8. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - 1. T 88 Particle Size Analysis of Soils
 - 2. State Department of Transportation (DOT): Standard Specifications for Construction and Materials, Latest Edition

1.4 QUALITY ASSURANCE

- A. An independent testing laboratory will perform testing at intervals not exceeding 75-feet of trench for first and every other 8-inch lift of compacted trench backfill and furnish copies of results as specified herein.

1.5 SUBMITTALS

- A. Shop drawings or details pertaining to site utilities are not required unless required by regulatory authorities or unless uses of materials, methods, equipment, or procedures that are contrary to Construction Drawings or Specifications are proposed. Do not perform work until Owner has accepted required shop drawings.
- B. Contact utility companies and determine if additional easements will be required to complete project. Provide written confirmation of the status of all easements to Owner at time of Preconstruction Conference or no later than 90 days prior to project possession date.
- C. Submit 30-pound sample of each type of fill material from off-site borrow sources that is to be used in backfilling, in air-tight container(s), to the independent testing laboratory or submit gradation and certification of aggregate material that is to be used at the site to the independent testing laboratory for review.

1.6 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of subsurface utilities, structures, and obstructions installed or encountered.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Bedding Material: Aggregate Type as indicated on the plans and local governing authorities bedding specifications for similar construction as specified in Section 31 0516.
- B. Haunching Material: As specified in Section 31 0516. Aggregate Type as indicated on the plans and local governing authority for similar construction as specified in Section 31 0516.
- C. Backfill material from the site as specified in Section 31 2300 and approved by Owner.
- D. Backfill material from off-site as specified in Section 31 2300 and approved by Owner.
- E. Steel Casing Pipe: Comply with AWWA C200 minimum grade B, size, and wall thickness as indicated on Construction Drawings.
- F. Backfill material shall not contain rock or stone with a maximum size greater than 2 inches.

2.2 LOCATOR TAPE

- A. Locator tape shall be heavy duty 6" wide underground warning tape. Tape shall be made from polyethylene material, 3.5 mils thick, with a minimum tensile strength of 1,750 psi. Place the tape at one-half the minimum depth of cover for the utility line or a maximum of 3', whichever is the lesser, but never above the top of subgrade. Color of tape shall be determined by APWA Color Standards: Natural Gas or Propane - Yellow, Electric - Red, Telephone – Orange, Water – Blue, Sanitary Sewer – Green.

2.3 EQUIPMENT

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

PART 3 EXECUTION

3.1 PREPARATION

- A. Set lines, elevations, and grades for proposed systems.
- B. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- C. Maintain in operating condition existing utilities, previously installed utilities, and drainage systems encountered in utility installation. Repair surface or subsurface improvements shown on Construction Drawings.
- D. Verify location, size, elevation, and other pertinent data required making connections to existing utilities and drainage systems as indicated on Construction Drawings.
- E. Over excavate and properly prepare areas of subgrade that are not capable of supporting proposed systems. Stabilize these areas by using acceptable geotextile fabrics or additional bedding material placed and compacted as specified in Section 31 3200.
- F. Provide dewatering systems as required for utility excavations. Dewatering systems shall comply with requirements of Section 31 2300.

3.2 EXCAVATION

- A. Contact local utility companies before excavation begins. Dig trench at proper width and depth for laying pipe, conduit, or cable. Cut trench banks vertical, if possible, and remove stones from bottom of trench as necessary to avoid point-bearing. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide suitable base for continuous and uniform bedding.
- B. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25-feet in trenches 4-feet or deeper.
- C. Perform excavation as indicated on Construction Drawings for specified depths. During excavation, stockpile materials suitable for backfilling in orderly manner far enough from bank of trench to avoid overloading, slides, or cave-ins.
- D. Remove excavated materials not required or not suitable for backfill or embankments and waste off site or at on-site locations approved by the Owner and in accordance with governing regulations.
- E. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches and other excavations.
- F. Open cut excavation with trenching machine or backhoe. Where machines other than ladder or wheel-type trenching machines are used, do not use clods for backfill. Dispose of unsuitable material and provide other suitable material at no additional cost to Owner.

- G. Excavated material containing dirt clods greater than 8-inches in largest dimension is unacceptable as fill. Clods and chunks of materials should be broken and the fill material mixed by disking, blading, or plowing, as necessary, so that a material of uniform moisture and density is obtained for each lift.
- H. Accurately grade trench bottom to provide uniform bearing and support for each section of pipe on bedding material at every point along entire length, except where necessary to excavate for bell holes, proper sealing of pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make joint connection properly.
- I. For pipes 12-inches in diameter or smaller, total trench width below top of pipe shall be the outside diameter plus not less than 12-inches nor more than 18-inches with the pipe or conduit that is to be installed to designated elevations and grades centered in the trench. For pipe diameters greater than 12-inches, trench width below the top of pipe shall be wide enough to accommodate workmen and equipment but not less than 18-inches. Other trench width for pipe, conduit, or cable shall be least practical width that will allow for proper compaction of trench backfill.
- J. Trench depth requirements measured from finished grade or paved surface shall meet the following requirements or applicable codes and ordinances, whichever is more stringent:
 - 1. Water Mains: 36-inches to top of pipe barrel or 6-inches below frost line, established by local building official, whichever is deeper.
 - 2. Sanitary Sewer: Elevations and grades as indicated on Construction Drawings.
 - 3. Storm Sewer: Elevations and grades as indicated on Construction Drawings.
 - 4. Electrical Conduits: 24-inches minimum to top of conduit or as required by NEC 300-5, NEC 710-36 codes, or local utility company requirements, whichever is deeper.
 - 5. TV Conduits: 18-inches minimum to top of conduit or as required by local utility company, whichever is deeper.
 - 6. Telephone Conduits: 18-inches minimum to top of conduit, or as required by local utility company, whichever is deeper.
 - 7. Gas Mains and Service: 30-inches minimum to top of pipe, or as required by local utility company, whichever is deeper.

3.3 PIPE BEDDING

- A. Accurately cut trenches for pipe or conduit that is to be installed to designated elevations, 4 inches below bottom of pipe and to the width as specified herein. Place 4 inches of bedding material, compact in bottom of trench, and accurately shape to conform to lower portion of pipe barrel.
- B. Place geotextile fabric as specified on Construction Drawings.

3.4 BACKFILLING

- A. Criteria: Do not backfill trenches until required tests are performed and utility systems comply with and are accepted by applicable governing authorities. If improperly backfilled, reopen to depth required to obtain proper compaction. Backfill and compact, as specified herein, to properly correct the condition in an acceptable manner.
- B. Backfilling: After pipe or conduit has been installed, bedded, and tested as required, backfill trench or structure excavation with specified material placed as given in the Construction Documents.
- C. Backfill trenches to contours and elevations shown on Construction Drawings with unfrozen materials.
- D. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

3.5 COMPACTION

- A. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.
- B. Maintain optimum moisture content of fill materials as specified in Section 31 2300 to attain required compaction density.
- C. Materials used for backfill shall comply with requirements of Section 31 0516 and as specified herein.

3.6 BORINGS AND CASINGS UNDER ROADS, HIGHWAYS, AND RAILROAD CROSSINGS

- A. When indicated by Construction Drawings, street, road, highway, or railroad crossings for utility mains installed by jacking and boring method shall be in accordance with area specifications and governing authorities.
- B. Excavation of approach pits and trenches within right-of-way of street, road, highway, or railroad shall be of sufficient distance from paving or railroad tracks to permit traffic to pass without interference. Tamp backfill for approach pits and trenches within right-of-way in layers not greater than 6-inches thick for entire length and depth of trench or pit. Compact backfill to 98 percent of maximum density in accordance with ASTM D698, obtained at optimum moisture as determined by AASHTO T 180. Mechanical tampers may be used after cover of 6 inches has been obtained over top of barrel of pipe.
- C. Accomplish boring operation using commercial type boring rig. Bore hole to proper alignment and grade. Bore hole shall be within 2-inches of same diameter as largest outside joint diameter of pipe installed. Install pipe in hole immediately after bore has been made and in no instance shall hole be left unattended while open.
- D. In event subsurface operations result in failure or damage to pavement or railroad tracks within 1 year of construction, make necessary repairs to pavement or railroad tracks at no additional cost to Owner. If paving cracks on either side of pipe line or is otherwise disturbed or broken due to construction operations, repair or replace disturbed or broken area at no additional cost to Owner.
- E. Clean, prime, and line interior and exterior of casing pipe with two coats of asphalt in accordance with area specifications and governing authorities.
- F. Butt weld steel casing. Welds shall be full penetration single butt-welds in accordance with AWWA C206 and AWS D7-0-62.
- G. Install casing and utility pipe with end seals, vent pipe, and other special equipment in accordance with area specifications and governing authorities.

END OF SECTION

SECTION 31 2318

ROCK EXCAVATION

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Removal of identified and discovered rock during excavation.
- B. Use of explosives to assist rock removal.
- C. Incorporating removed rock into fills and embankments.

1.2 RELATED SECTIONS

- A. Section 31 1000 – Site Clearing
- B. Section 31 2300 - Earthwork
- C. Section 31 2316 – Trenching and Backfill
- D. Construction Drawings

1.3 REFERENCE STANDARDS

- A. National Fire Protection Association (NFPA)
 - 1. NFPA 495 Code for Manufacturing, Transportation, Storage, And Use of Explosive Material
- B. United States Department of Interior, Bureau of Mines, Seismic Effects of Blasting (Latest Edition)
- C. Occupational Safety & Health Administration (OSHA)
 - 1. 29CFR 1910.109 Explosives and Blasting Agents

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Determine environmental effects associated with proposed work and safeguard those concerns as regulated by law and local governing agencies by reasonable and practical methods.

1.5 DEFINITIONS

- A. "Rock Excavation" is defined as removal of igneous, metamorphic or sedimentary rock or stone, boulders over two (2) cubic yards in volume in open areas and one (1) cubic yard in volume in trenches; masonry or concrete or solid frozen soil; that cannot be removed by rippers or other mechanical methods and, therefore, requires drilling and blasting. The word "trenches" shall mean excavations having vertical sides whose depths exceed its width, made for storm water drainage, sanitary sewer, water, and gas pipes, electric, communications, and steam conduits, and related uses.

1.6 SCOPE

- A. Perform the Work in accordance with all pertinent Federal, state and local regulations.

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- B. "Rock Excavation" contract requirements are provided in the General and Supplementary Conditions provided in the Project Manual.
- C. This Section includes furnishing all drilling, blasting and protection required to complete the work indicated on the Drawings and as specified herein.
- D. The Contractor shall be responsible for any and all damage and/or injury from the use of explosives. The Contractor shall save and hold harmless the Owner, Architect and Engineer from any and all claims from the use of explosives. Removal of materials of any nature by blasting shall be done in such a manner and at such times as to avoid damage affecting integrity of existing construction and damage to new or existing dwellings, structures and water wells in or adjacent to the area of the work. It shall be the Contractor's responsibility to determine the method of operation to ensure desired results and integrity of completed work. All damage caused by the Contractor's blasting operations shall be repaired to the full satisfaction of the Owner at no additional cost to the Owner.

1.7 PERMITS AND LICENSES

- A. Prior to rock excavation, Contractor shall obtain all necessary permits from regulatory agencies. If blasting is required or undertaken, the responsible Subcontractor shall be licensed in the State and shall possess a current blasting license issued by the appropriate regulatory authority and be permitted for the transportation of explosives if required.

1.8 SUBMITTAL

- A. The Contractor shall provide Blasting Plan (prior to any blasting) and Monitoring Reports to the Owner and Governing Agencies for review.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Explosives, detonator/delay device, and blast mat materials shall be type recommended by explosive supplier and shall comply with requirements specified herein.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify site conditions and note subsurface conditions affecting work of this section.
- B. Identify required lines, levels, and elevations that will determine extent of proposed removals.

3.2 ROCK EXCAVATION

- A. Cut rock to form level bearing at bottom of footing and trench excavations. Remove shaled layers to provide sound and unshattered base for footings or foundations. Contractor shall consider reuse of excavated materials on site in accordance with Section 31 2300. If material cannot be utilized on site, then Contractor shall dispose of material offsite at no additional cost to the Owner.
- B. If placed in embankments, perform rock excavation in manner that will produce material of such size as in accordance with Section 31 2300. Remove rock to allow for construction and/or installation of the site and building improvements as indicated on Construction Drawings. Remove loose or shattered rock, overhanging ledges and boulders, which might dislodge.

- C. Use lean concrete or suitable materials as directed by registered geotechnical engineer to replace rock overblast or over excavation in building and expansion area to facilitate placement of utilities and foundations systems.

3.3 ROCK BLASTING

A. General

1. The drilling and blasting methods and programs shall be those necessary to accomplish any and all rock excavation required for completion of the improvements shown on the Construction Drawings in accordance with the procedures specified herein. Do not use explosives as a primary means of transporting material outside the excavated prism.
2. Blasting work shall be performed only with necessary permits from all regulatory authorities and after completion of the preblast survey. Blasting work shall take place only after persons in the vicinity have been notified and have reached positions of safety. Take appropriate precautions to prevent all persons from entering the blasting area. Use methods and programs that will prevent damage to, but not limited to, adjacent dwellings, structures, public domain, natural resources, habitat, existing wells and landscape features and that will minimize the scattering of rock, stumps or other debris. All affected roadways shall be inspected, cleared, and opened to traffic within 1 (one) hour of completed blasting or as required by governing authorities.
3. Complete all blasting with experienced powdermen licensed to use explosives in the State.
4. Conduct blasting at such ("10:00 a.m. to 3:00 p.m.") hours so as not to disrupt surrounding residences and businesses, and in accordance with Federal, state and local regulations and/or ordinances with regard to noise.
5. Take all precautions necessary to warn and/or protect any individuals exposed to his operations prior to any blasting. Blasting mats or other approved flyrock protection shall be employed as necessary to protect areas adjacent to blasting.
6. Develop and maintain records covering pertinent data on the location, depth and area of the blast, the diameter, spacing, depth, overdepth, pattern, amount, distribution and powder factor for the explosives used per hole and per blast; the sequence and pattern delays, and description and purpose of special methods. Provide a copy of the records to the Owner upon the Owner's request. Receipt and acceptance by the Owner of blasting data will not relieve the Contractor of his responsibility to produce satisfactory results as set forth in these specifications. Drilling and blasting shall be done only to the depth, amount and at such locations, with explosives of such quantity, distribution, and density that will not produce unsafe or damage rock surfaces or damage rock beyond the prescribed excavation limits. The Contractor shall be responsible for the cost of removal of overblast and also for the cost of placement and compaction of suitable replacement fill where overblast removal is required or occurs.
7. When a drilling and blasting program results in damage to the excavation or unacceptable peak particle velocity or frequency values as specified in Section 3.3. D. below, the Contractor will be required to devise and employ revised methods that will prevent such damage or unacceptable ground motions at no cost to the Owner. The revisions may include special methods such as presplit and zone blasting, shallow lifts, reduction in size of individual blasts, small diameter blast holes, closely spaced blast holes, reduction of explosives, greater distribution of explosives by use of decking and primacord or variation in density of explosives and chemical or mechanical splitting of the rock.

B. Codes, Permits And Regulations

1. Comply with all applicable laws, rules, ordinances and regulations of the Federal, State and local regulatory authorities and insurers that govern the licensing, transportation, storage, handling, use, and disposition of explosives.
2. Obtain and pay for all powder and blasting permits and licenses required to complete the work of this Section as defined in the General and Supplementary Conditions.

3. In case of conflict between regulations or between regulations and Specifications, the Contractor shall comply with the strictest applicable codes, regulations or Specifications.
- C. Explosives
 1. Take special precautions for proper use of explosives to prevent harm to human life and damage to surface structures, utility lines, or other subsurface structures.
 2. Store, handle, and employ explosives in accordance with Federal, state and local regulations, or, in the absence of such, in accordance with the provisions of the NFPA and OSHA.
- D. Blasting Vibration And Limit Criteria
 1. The amount of vibration, frequency and overpressure generated by blasting shall not exceed regulatory statutes or directives established by State, local or other authorities. In no case shall the maximum Peak Particle Velocity (PPV) exceed the limits indicated on Figure B-1, Appendix B, of the United States Bureau of Mines Report of Investigations, RI 8507, 1980 or latest edition.
 2. The peak airblast overpressure measured at the location of the nearest occupied, aboveground structure (considering wind direction) shall not exceed 0.014 psi.
- E. Preblast Survey
 1. General:
 - a. Conduct a preblast survey prior to initiating any blasting work. The Contractor shall have the preblast survey performed by a registered Professional Engineer or specialized consultant licensed in the State of the work covered under this contract and specialized in conducting preblast surveys.
 - b. The work to be performed for the preconstruction/preblast survey will consist of documenting conditions of all existing dwellings and structures located within a minimum of 1000 feet of the limits of all work requiring rock blasting prior to commencement of blasting or further if required by Federal, state or local regulations.
 - c. The purpose of the preblast survey is to determine the conditions of existing dwellings, structures and water supply wells and document any pre-existing defects and other physical factors that could reasonably be affected by the blasting. Structures such as dams, ponds, pipelines, cables and transmission lines, cisterns, structures of historical significance, and/or structures with unusually costly or vulnerable contents shall be included. The preblast survey shall also note the nature and sensitivity of livestock that may be affected by the blasting.
 2. Examination of and Preparation for Survey:
 - a. The Contractor shall contact the property owners (or their legal representative) of properties within a minimum of 1000 feet of the limits of all blasting work in order to obtain permission to conduct a survey of their property. If the property owner does not grant the Contractor permission to conduct the survey, the Contractor shall contact the property owner a second time by registered mail/return receipt requested. The second request for permission to conduct the survey shall include a description of the survey to be performed and the purpose of the survey. At least 72 hours prior to start of blasting work, notify the appropriate local regulatory authority of any property owners who refuse access for the preconstruction survey.
 - b. Notify the property owners at least 48 hours prior to conducting the preblast survey. After completion of the survey, two copies of the preblast report will be submitted to the appropriate local regulatory authority for their reference if required. Additionally, one copy shall be kept on file at the location of the project and one copy provided to the Owner upon request.
 3. Method:
 - a. The preblast survey shall include a detailed examination of the interior and exterior of structures located within a minimum of 1000 feet of the limits of all blasting work. Color photographs, videotapes, and written descriptions

shall be taken as required to document the condition of areas within the limits of the survey area. Particular note shall be made of evident structural faults or deficiencies, or recent repairs.

- b. The preblast survey shall also include an assessment of water supply wells located within a minimum 1000 feet of the limits of all blasting work. This assessment shall include the following items:

- 1) Information regarding the date of construction of the well, depth, method of construction, yield, water quality and any other existing available data will be requested from each well owner and/or the installer, provided the installer is known.
- 2) A short duration pump test shall be performed on each well utilizing the existing pump that services each well. The pump shall be activated, the volume of water measured and the drawdown in the well measured for a 1-hour or less period until approximate steady state conditions are achieved. The data obtained from these measurements shall be used to estimate the approximate yield of each well.
- 3) Upon completion of the above-described short duration pump test, obtain a groundwater sample from the well and submit to a State certified water quality laboratory. Laboratory shall analyze sample for iron, manganese, total dissolved solids, turbidity and total coliform.

4. Survey Report:

- a. The Contractor shall prepare a written report summarizing the results of the preblast survey. The final written report shall be signed and sealed by the Contractor's qualified inspector. The report shall contain the following:
- 1) Location and description of each property
 - 2) Descriptions of the conditions of the on-site elements
 - 3) Summary of the visual inspection
 - 4) Color photographs, sketches, and videotape with vocal summary
 - 5) All data developed from the water supply well assessment
- b. Provide videotapes to include supplemental information, as required. Pictorial documentation shall be of professional quality and shall be provided with a scale, where practicable. Clearly label pictorial documentation with an identification number, name of the project and the Engineer or qualified person conducting the survey, name of the property owner, date the picture or video tape was taken, and sufficient information to determine the location of the area in question.
- c. The Contractor's inspector shall immediately report in writing to the Contractor any findings that, in his opinion, indicate that any structure or well will be adversely affected by the required construction and blasting.
- d. If, during the course of construction and blasting, the Contractor is requested by an adjacent property owner to view alleged damage to property, the Contractor shall give written notice to the Owner prior to the Contractor's visit to the adjacent owners property.

F. Blast Monitoring

1. Contractor shall perform seismic blast monitoring in accordance with State and local regulations.
2. Contractor shall provide monitoring of blasting vibrations and over-pressures to allow evaluation of compliance with the specified vibration/over-pressures to criteria. As a minimum, the Contractor will monitor each blast as follows:
 - a. Monitor vibrations at the exterior walls of all structures within 1000 feet of each blast location.
 - b. If no structures are located within 500 feet of the blast location, monitor vibrations at three equally spaced radial points located a minimum of 1000 feet from the blast locations.
 - c. Monitor over-pressures for all structures within a minimum 1000 feet of the blast.
3. If requested by the Owner, report vibration/overpressure-monitoring results to the Owner within two hours of blasting. Monitoring performed by the Contractor does

not relieve the Contractor of his responsibility for control of vibration and overpressure during blasting operations.

3.4 ROCK CUT FACE EXCAVATION

- A. The slope of the soil above the top of any permanently exposed rock cut face shall be no steeper than 3(H):1(V) unless otherwise noted on the Construction Drawings. Slope of the rock face shall meet the requirements set forth in the Geotechnical Investigation.
- B. Benches of at least ten (10) feet in width at a maximum of twenty (20) feet in elevation intervals or as noted on the Construction Drawings. The benches are to provide rock traps and divert water from the rock face.

3.5 ROCK TRAP

- A. Locate rock traps at the base of permanently exposed rock slopes and construct as indicated in the Construction Documents or Blasting Plan.

3.6 OVEREXCAVATION AND BACKFILL

- A. Over excavation, which is required to remove unsuitable natural undisturbed bedrock weakened by weathering or other cause not inflicted by the Contractor shall be immediately reported to the Owner and performed as directed by the Owner, and the theoretical lines and grades will be adjusted accordingly. Material outside the excavation limits which are disturbed due to the fault or negligence of the Contractor or due to his failure to exercise sound construction practices, shall be either replaced by him with suitable materials (earth or concrete), or bolted, or both as directed, at no cost to the Owner.

END OF SECTION

SECTION 31 2500

EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SUMMARY

- A. Section Includes
 - 1. Installation of temporary and permanent erosion and sedimentation control systems.
 - 2. Installation of temporary and permanent slope protection systems.
- B. Related Sections
 - 1. Section 31 1000 – Site Clearing
 - 2. Section 31 2300 – Excavation and Fill
 - 3. Section 32 9000 – Planting
 - 4. Storm Water Pollution Prevention Plan (SWPPP), if applicable
 - 5. Construction Drawings

1.2 ENVIRONMENTAL REQUIREMENTS

- A. Protect adjacent properties, any identified endangered or threatened species or critical habitat, any identified cultural or historic resources, and receiving water resources from erosion and sediment damage until final stabilization.
- B. Storm water Pollution Prevention Plan, if applicable.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Seed, sod, and ground covers for the establishment of vegetation in accordance with Section 32 9000.
- B. Sediment control devices as specified on the Construction Drawings.
- C. Temporary mulches such as loose, straw, wood cellulose, or agricultural silage.
- D. Temporary and permanent outfall structures as specified on the drawings.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Review the drawings and SWPPP, if applicable.
- B. Contractor Responsible for the SWPPP.
- C. Contractor shall prepare the NOI Operator application and submit to the appropriate state authority prior to construction.
- D. Conduct pre-construction meeting with Site Contractor and all ground-disturbing Sub-contractors.
- E. Contractor to prepare Site Construction Notice per state guidelines.

3.2 EROSION AND SEDIMENTATION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

- A. Place erosion and sediment control systems in accordance with the drawings or as may be dictated by site conditions in order to maintain the intent of the specifications and permits.
- B. Deficiencies or changes on the drawings shall be corrected or implemented by contractor as site conditions change. Changes during construction shall be noted on the drawings (Site Maps) by contractor.
- C. Owner has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures.
- D. Maintain temporary erosion and sedimentation control systems as dictated by site conditions, indicated in the construction documents, or as directed by governing authorities or Owner to control sediment until final stabilization. Contractor shall respond to maintenance or additional work ordered by Owner or governing authorities immediately, but in no case, within more than 48 hours if required at no additional cost to the Owner.
- E. Contractor shall incorporate permanent erosion control features, paving, permanent slope stabilization, and vegetation into project at earliest practical time to minimize need for temporary controls.
- F. Permanently seed and mulch cut slopes as excavation proceeds to extent considered desirable and practical.
- G. Slopes that erode easily or that will not be graded for a period of 14 days or more, shall be temporarily seeded as work progresses with wheat, rye, or oats unless otherwise specified in the Contract Documents. In the event it is not practical to seed areas, slopes must be stabilized with erosion blanket or other means to reduce the erosive potential of the area.

END OF SECTION

SECTION 31 3116
TERMITE CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Chemical soil treatment.

1.02 REFERENCE STANDARDS

- A. Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act; 1947 (Revised 2001).

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
- C. Test Reports: Indicate regulatory agency approval reports when required.
- D. Manufacturer's Certificate: Certify that toxicants meet or exceed specified requirements.
- E. Certificate of compliance from authority having jurisdiction indicating approval of toxicants.
- F. Manufacturer's Application Instructions: Indicate caution requirements and materials list of proposed items to be provided under this section.
- G. Record and document moisture content of soil before application, date and rate of application, areas of application, and diary of toxicity meter readings and corresponding soil coverage.
- H. Installer Qualifications: Company specializing in performing work of the type specified and with minimum 5 years years of documented experience.
- I. Maintenance Data: Indicate re-treatment schedule .
- J. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing this type of work and:
 - 1. Having minimum of 5 years documented experience.
 - 2. Approved by manufacturer of treatment materials.
 - 3. Licensed in Texas.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year installer's warranty against damage to building caused by termites.
 - 1. Include coverage for repairs to building and to contents damaged due to building damage. Repair damage and, if required, re-treat.
 - 2. Inspect annually and report in writing to Owner. Provide inspection service for 5 years from Date of Substantial Completion.
 - 3. Make inspections, retreatment, and repairs at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 CHEMICAL SOIL TREATMENT

- A. Toxicant Chemical: EPA (Title 7, United States Code, 136 through 136y) approved; synthetically color dyed to permit visual identification of treated soil.
- B. Diluent: Recommended by toxicant manufacturer.
- C. Manufacturers:
 - 1. Bayer Environmental Science Corp: www.backedbybayer.com/pest-management.
 - 2. FMC Professional Solutions: www.fmcprosolutions.com.
 - 3. Syngenta Professional Products: www.syngentaprofessionalproducts.com.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.

- D. Mixes: Mix toxicant to manufacturer's instructions.
- E. If combinations of toxicants are approved by governmental agencies having jurisdiction, provide toxicants having such approval and in the maximum strength so approved, at no additional cost to the Owner.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
- B. Verify final grading is complete.

3.02 APPLICATION - CHEMICAL TREATMENT

- A. Comply with requirements of U.S. EPA and applicable state and local codes.
- B. Spray apply toxicant in accordance with manufacturer's instructions.
- C. Apply toxicant at following locations:
 - 1. Under Slabs-on-Grade.
 - 2. In Crawl Spaces.
 - 3. At Both Sides of Foundation Surface.
 - 4. Utility Entrances
 - 5. Immediately below expansion joints, control joints, and all areas where slab will be penetrated by construction features.
 - 6. Where exterior facings or veneers extend below grade level along the exterior side of all foundation walls.
 - 7. Where unit masonry foundation construction is used.
- D. Under slabs, apply toxicant immediately prior to installation of vapor barrier or void forms.
- E. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.
- F. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.
- G. Re-treat disturbed treated soil with same toxicant as original treatment.
- H. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.03 PROTECTION

- A. Do not permit soil grading over treated work.

END OF SECTION

SECTION 31 3200

SOIL STABILIZATION

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Excavation, treatment, and backfilling of subgrade for lime stabilization.
- B. Excavation, treatment, and backfilling of subgrade for cement stabilization.
- C. Excavation, treatment, and backfilling of subgrade for fly ash stabilization.
- D. Excavation, treatment, and backfilling of subgrade for bridge lift stabilization.
- E. Installation of Geotextile Fabric and/or Geogrid for stabilization of subgrade.

1.2 RELATED SECTIONS

- A. Section 31 2300 – Excavation and Fill
- B. Section 31 0516 - Aggregates for Earthwork
- C. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing Materials (ASTM) latest edition
 - 1. C 150 Portland Cement
 - 2. C 618 Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
 - 3. C 977 Quicklime and Hydrated Lime for Soil Stabilization
 - 4. D 1633 Compressive Strength of Molded Soil-Cement Cylinders
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - 1. M 216 Lime for Soil Stabilization
- C. National Lime Association (NLA)
 - 1. Bulletin 326 Lime Stabilization Construction Manual
- D. North Central Texas Council of Governments

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Do not install mixed materials in wind in excess of 10 mph or when temperature is below 40 degrees Fahrenheit.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with state and local standards in conjunction with requirements specified herein.

1.6 SUBMITTALS

- A. Submit 30-pound sample of each material to be used at the site in airtight containers to the independent testing laboratory or submit gradation and certification of material that is to be used to the independent testing laboratory for review.
- B. Submit name of each materials supplier and specific type and source of each material. Change in source requires approval of Owner.
- C. Submit mix design and materials mix ratio that will achieve specified requirements of state and local agencies for soil stabilization.
- D. If geogrids or geotextiles are to be used, design shall be submitted to Owner for approval. See Section 31 2300.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Hydrated Lime
- B. Portland Cement: ASTM C150, Normal Type I
- C. Fly Ash: ASTM C977 or AASHTO M216
- D. Coarse Aggregate: Type A1
- E. Fine Aggregate: Type A4
- F. Subsoil: Existing to be Reused, Type S1

2.2 ACCESSORIES

- A. Curing Seal: Asphalt Emulsion Primer
- B. Geotextile Fabric for Stabilization
 - 1. Mirafi 500X or 600X
 - 2. Phillips 66 Supac 6WS
 - 3. Dupont Tyvar 3401 and 3601
 - 4. Trevira S1114 and S1120
 - 5. Tensar SS-1 and SS-2
 - 6. Exxon GTF-200 or 350
 - 7. TerraTex HD and GS
- C. Geogrid for Stabilization
- D. Tensar BX 1100
- E. Tensar BX 1200

2.3 EQUIPMENT

- A. Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

PART 3 EXECUTION

3.1 PREPARATION

- A. Obtain approval from the independent testing laboratory of mix design before proceeding with placement.
- B. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.
- C. Proofroll subgrade to identify areas in need of stabilization.

3.2 EXCAVATION

- A. Excavate subsoil to depth sufficient to accommodate soil stabilization.
- B. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.
- C. Do not excavate within normal 45 degree bearing splay of any foundation.
- D. Notify Construction Manager of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.
- E. Correct areas over-excavated in accordance with Section 31 2300.
- F. Remove excess excavated material from site.

3.3 GEOTEXTILE FABRIC AND/OR GEOGRID

- A. Place geotextile fabric and/or geogrid over subsoil surface, lap edges and ends in accordance with manufacturer's recommendations in those areas that are shown on Construction Drawings, or beneath rock riprap, or in those areas that need additional stabilization prior to placement of base course. Bridge lift sections may require the use of geotextile fabric and/or geogrid for stabilization prior to placement of fill.
- B. Place geotextile fabric and/or geogrid specified on Construction Drawings and in Specifications in accordance with manufacturer's recommendations.

3.4 SOIL TREATMENT AND BACKFILLING

- A. Lime Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with hydrated lime in accordance with state department of transportation specifications.
- B. Cement Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with portland cement in accordance with state department of transportation specifications.
- C. Fly Ash Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with fly ash in accordance with state department of transportation specifications.

- D. Bridge Lifts: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade by application of a bridge lift. Bridging over existing soils shall be acceptable only when approved in writing by the Owner. Place geotextile fabric or geogrid over existing soils to be bridged. The geotextile fabric or geogrid selected shall be appropriate for the bridge lift material being placed. Place bridge lift over geotextile fabric or geogrid. Bridge lift material may be surge stone, granular fill, or shot rock fill. Surge stone and shot rock will be approved by the Owner's representative on a submittal basis. The Owner and the Owner's representative shall have sole discretion as to the acceptability of all submittals.
- E. Backfill and compaction of treated subsoil shall be in accordance with Section 31 2300.
- F. Maintain optimum moisture of mixed materials to attain required stabilization and compaction.
- G. Finish subgrade surface in accordance with Section 31 2300.
- H. Remove surplus mix materials from site at no additional cost to the Owner.

3.5 CURING

- A. Immediately following compaction of mix, seal top surface with curing seal.
- B. Do not permit traffic for 72 hours after sealing top surface.

3.6 FIELD QUALITY CONTROL

- A. Compression test and analysis of hardened fill material will be performed in accordance with Section 31 2300.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION

SECTION 31 6329
DRILLED CONCRETE PIERS AND SHAFTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Machine drilled shaft.
- B. Concrete and reinforcement.
- C. Shaft liner, if required.

1.02 RELATED REQUIREMENTS

- A. Section 01 1400 - Work Restrictions
- B. Section 01 4000 - Contractor's Quality Assurance
- C. Section 01 4533 - Code-Required Quality Control
- D. Section 03 2000 - Concrete Reinforcing: Requirements for concrete reinforcement.
- E. Section 03 3000 - Cast-in-Place Concrete: Requirements for concrete.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Proposers shall assume all drilled piers shall be installed as shown on the construction documents as part of the construction, with adjustments made by unit price. The same unit price shall be used for adding linear feet as is used for deducting linear feet. If more than one unit price is submitted for each type, (e.g. if a different price is submitted for adding than for deducting), the average of the absolute values shall be used for adding and deducting. Proposers shall provide a unit price for each type of pier, \$/LF, with the Proposal. If a unit price is not provided with the Proposal and made part of the Agreement with the Owner, the Contractor shall not begin installation of drilled piers until a unit price is proposed and the Owner agrees to the unit price. If a unit price is not agreed to by the Owner before drilled piers begin, the Architect will establish a unit price that the Architect believes to be fair and reasonable, based solely on the Architect's opinion, to make any cost adjustments if the actual piers vary from the designed piers. The Proposal and Unit Prices shall include costs of mobilizing equipment. For example, if equipment needs to be remobilized to drill piers at the end of the project, the Owner shall not be responsible for the costs of remobilization.
- B. Designed Piers:
 - 1. Design Pier Quantity: Determined by the quantity of piers indicated in the Contract Documents. Refer to Typical Details and Plans. The Plans may not show all piers required by the typical details at, for example, site structures such as fences.
 - 2. Design Pier Length: By the linear foot measured from bottom of pier to top of pier elevation as indicated.
 - 3. Pier Casings: By the linear foot. For proposal purposes, Proposers shall assume that 100% of the drilled piers will require casing.
- C. Actual Piers:
 - 1. Actual Pier Quantity: Determined by quantity of piers identified in the Project Record Documents.
 - 2. Actual Pier Length: Determined by length of piers identified in Project Record Documents.
 - 3. Pier Casings: By the linear foot. The actual cased length shall be defined from the top of the pier to the bottom of the casing. Any pier penetration below the bottom of the casing shall be considered uncased pier length.
- D. Adjustments to the Contract Sum/Price will be made if the Actual Pier Quantity or Length differs from Design Pier Quantity or Length, based on unit prices established in the Agreement and as follows:
 - 1. Unit price per unit length. To calculate cost adjustment, multiply unit price by difference between the sum of the total Design Pier Lengths for all piers of each type on the project and Actual Pier Lengths for all piers of each type on the project.

2. The Contractor shall not be compensated for penetrations deeper than indicated to be required by the Owner's Testing Laboratory
- E. Determination of Unit Measurements: Identified by site measurements and verified by Owner's testing laboratory. The Contractor shall notify the Laboratory when the last pier has been drilled and request a report from the Laboratory to assist with the calculation of cost adjustment. The Laboratory shall determine the difference between the sum of the total Design Pier Lengths for all piers of each type on the project and Actual Pier Lengths for all piers of each type on the project

1.04 REFERENCE STANDARDS

- A. ACI 336.1 - Standard Specification for the Construction of Drilled Piers; 2001.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- C. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2013.
- D. ASTM A929/A929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe; 2001 (Reapproved 2013).

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.

1.06 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Project Record Documents: Record actual locations of piers, pier diameter, and pier length. Accurately record the following:
 1. Sizes, lengths, and locations of piers.
 2. Sequence of placement.
 3. Final base and top elevations.
 4. Deviation from indicated locations.
 5. Placement and configuration of reinforcement deviations.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Casing: Temporary casings of steel conforming to ASTM A 36 of sufficient strength to withstand handling and drilling stresses, concrete pressures, and surrounding earth and water pressures.
- B. Concrete Materials and Mix: Specified in Section 03 3000.
- C. Reinforcement: Specified in Section 03 2000; spiral wound. Spiral bars shall be smooth rod spiral, not deformed rebar. Vertical pier reinforcement shall not be spliced. Vertical bars shall be shipped to the project in stock lengths and field cut after measuring each pier.
- D. Equipment: Appropriate for dewatering excavated shaft.
- E. Reinforcement Supports:
 1. Manufacturers
 - a. Subject to compliance with requirements indicated herein, provide products of one of the listed manufacturers.
 - b. Pier Sleds and Bolsters:
 - 1) Pieresearch, 501 East Main Street, Arlington, TX, 800-342-2409, www.pieresearch.com.
 - 2) Foundation Technologies, Inc., Tucker, GA, www.foundationtechnologies.com.

- 3) Blackthorn, Inc., 6113 Brookville Sale Road, Clayton, OH,
www.blackthorn-inc.com.
- 4) EZ-Lok Products by Dayton Superior, 1002 Avenue T, Grand Prairie, TX,
800-745-3703, www.daytonsuperior.com.
- 5) Substitutions under provisions of Section 01 6000 - Product Requirements.
2. Pier Sled or Wheel Spacers
 - a. Pier sleds shall be fabricated concrete support with minimum compressive strength of 8,500 psi and integral wire ties.
 - b. Wire ties: plain finish.
 - 1) Manufactured sizes:
 - (a) Nominal 8 x 3 x 1-1/4 inch
 - (b) Nominal 8 x 4 x 1-1/4 inch
 - (c) Use 3-inch sled for uncased and 4-inch sled for cased piers.
 - c. Wheel spacers shall be EZ-LOK - PLW-300/4-HD, 3/4-inch thick.
 - d. Provide minimum three sleds or wheels around the cage at 10'-0" maximum on center spaced uniformly to properly align cage in shaft.
3. Pier Bolster
 - a. Fabricated concrete support with minimum compressive strength of 8,500 psi and integral wire ties.
 - 1) Wire ties: plain finish.
 - 2) Manufactured size: nominal 4-inch diameter by 3-inch high with two 9-gage wires for attachment to bottom of reinforcing cage.
 - b. Minimum number of bolsters per cage, spaced to support steel free of earth:

Diameter in Inches	Under 30"	30" to 48"	49" to 72"
Number of Pier	2	4	6
Bolsters per Pier			
Shaft			

PART 3 EXECUTION

3.01 PREPARATION

- A. Use placement method which will not cause damage to nearby structures.
- B. Notify adjacent and affected land owners and building occupants before proceeding with the work.
- C. Protect structures near the work from damage.
- D. Prepare to place piers from excavated working elevation.
- E. Grade perimeter of pier and shaft area to prevent surface water from draining into soil borings. Provide temporary means and methods, as required, to maintain surface diversion until no longer needed, or as directed by the Architect.
- F. Test Pier Holes: (The paragraphs below shall not apply to light pole bases.)
 1. The Contractor shall drill all Test Pier Holes (belling and/or dewatering if required) as indicated on the Structural Drawings in the presence of the Special Inspection and Testing Agency (SITA). If none are shown on the Structural Drawings, the Contractor shall drill one Test Pier Hole (to the diameter and depth required for a type "A" pier, belling if required for a type "A" pier) for every 50,000 square feet of floor plan within the building area with the location(s) to be determined by the SITA.
 2. Within one (1) business day after receiving the Test Pier Hole Report from the SITA, the Contractor shall forward the report to the Structural Engineer with a Request for Information (RFI), requesting verification that the conditions encountered are generally consistent with those required for proposal purposes (total lineal feet of cased and uncased piers). If conditions are significantly different from what was anticipated, the Structural Engineer may recommend modification of the pier design(s).

3.02 INSTALLATION

- A. Refer to Section 01 1400 for work restrictions regarding the schedule of drilled pier installation.
- B. Construct piers in accordance with ACI 336.1.
- C. Drill vertical pier shafts to diameters and depths indicated.
- D. Place steel casings during drilling operations. Set firmly in place. If casing is to be temporary, install shaft liner with sufficient strength to withstand concrete pressures.
 - 1. Withdrawal of temporary casings is at option of Contractor.
- E. Clean shaft and bottom of loose material. Maintain shafts free of water.
- F. Allow inspection of shaft prior to placement of reinforcement and concrete.
- G. Place reinforcing steel in accordance with Section 03 2000.
- H. Fabrication and Placing of Reinforcing
 - 1. All steel reinforcing cages shall be completely fabricated in a rigid fashion in order to permit expeditious placement into the shaft excavation by service equipment with a minimum time delay.
 - 2. The reinforcing steel cage for the shafts, consisting of longitudinal bars and hoops or ties, shall be completely assembled and placed into the shaft as a unit. Each longitudinal bar shall be tied to each hoop or tie.
 - 3. Place pier bottom bolsters in accordance with manufacturer's recommendations.
 - 4. Place pier side sleds in accordance with manufacturer's recommendations.
- I. Place concrete in single pour, in accordance with Section 03 3000 with equipment designed for vertical placement of concrete.
- J. Placing of Concrete
 - 1. Concrete may be placed through a tremie if desired by the Contractor if concrete will not strike the side of the shaft.
 - 2. Concrete shall be placed as soon as practical after the pier excavation has been completed and in no case shall the time lapse between completion of the excavations and concrete placement therein exceed four (4) hours (no pier excavation shall be left open overnight).
 - 3. Placement of concrete in any individual shaft shall be continuous from the beginning of concrete placement to the completion of any individual shaft installation. Concrete shall be vibrated.
- K. Coordinate casing withdrawal with concrete placement so that concrete pressure head exceeds anticipated outside soil and water pressure above bottom of casing at all times during withdrawal. Vibration and rotation will not be permitted during extraction of the casing and special care shall be exercised to insure that separation or squeezing of the freshly placed concrete does not occur. At all times during extraction of the casing, the concrete head within the casing shall be sufficient to prevent encroachment of ground water or caving material into the freshly placed concrete.
- L. Extend reinforcement or provide dowels for connection of caps and grade beams.
- M. Set tops of piers to elevations indicated.

3.03 TOLERANCES

- A. Install piers with maximum variation from location, plumbness, bottom area, diameter, and anchorage locations as specified in ACI 336.1.
- B. Maximum Variation From Vertical: 1 in 48.
- C. Maximum Variation From Design Top Elevation: Plus 3 inches, minus 1 inch.
- D. Maximum Out-of-Position: 2 inches.

3.04 FIELD QUALITY CONTROL

- A. A Special Inspection and Testing Agency (SITA) will perform field quality control tests and inspections, as specified in Sections 01 4516 and 01 4533.

3.05 UNACCEPTABLE PIERS

- A. Unacceptable Piers: Piers that fail, are placed out of position, are below elevations, or are damaged.
- B. Provide additional piers or replace piers failing to conform to specified requirements.

END OF SECTION

SECTION 32 1313

CONCRETE PAVING

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Preparation and placement of cement concrete parking areas, roads and entrances.

1.2 RELATED SECTIONS

- A. Section 31 2300 – Excavation and Fill
- B. Section 32 1723- Pavement Markings
- C. Section 32 1613 - Curbs and Sidewalks
- D. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
 - 1. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - 2. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. 305R Hot Weather Concreting
 - 4. 306R Standard Specification for Cold Weather Concreting
 - 5. 308 Standard Practice for Curing Concrete
 - 6. 309R Guide for Consolidating of Concrete
 - 7. 330.1 Standard Specifications for Plain Concrete Parking Lots
 - 8. 330R Guide for Design & Construction of Concrete Parking Lots
- B. American Society for Testing and Materials (ASTM) latest edition
 - 1. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 2. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
 - 3. C33 Concrete Aggregates
 - 4. C78 Method for Flexural Strength Concrete (Using Simple Beam with Third-point Loading)
 - 5. C94 Ready-Mixed Concrete
 - 6. C143 Method for Slump of Hydraulic Cement Concrete
 - 7. C150 Portland Cement
 - 8. C171 Sheet Material for Curing Concrete
 - 9. C231 Air-Content of Freshly Mixed Concrete by the Pressure Method
 - 10. C260 Air-Entraining Admixtures for Concrete
 - 11. C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 12. C494 Chemical Admixtures for Concrete
 - 13. C920 Standard Specification for Elastomeric Joint Sealants
 - 14. C979 Standard Specification for Pigments for Integrally Colored Concrete
 - 15. D994 Preformed Expansion Joint Filler for Concrete (Bituminous)
 - 16. D1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 - 17. D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- C. State Department of Transportation Standard Specifications

1.4 QUALITY ASSURANCE

- A. Establish and maintain required lines and elevations.
- B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.

1.5 SUBMITTALS

- A. Submit materials certificate from materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein to the Engineer and the independent testing laboratory for review and approval and within 7 calendar days after receipt of Notice-to-Proceed, submit for approval, certified laboratory test data or manufacturers certificates and data for the following items:
 - 1. Portland cement concrete mix
 - 2. Aggregate gradations
 - 3. Preformed expansion joint filler
 - 4. Field molded/poured sealant
 - 5. Dowel bars
 - 6. Expansion sleeves
 - 7. Tie bars
 - 8. Reinforcing steel bars
 - 9. Welded wire fabric
 - 10. Air entraining admixtures
 - 11. Water-reducing and set-retarding admixtures (if used)
 - 12. Coloring agents / admixtures

1.6 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary fencing, striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets.
- C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.
- D. Portland Cement: Shall conform to ASTM C150, Type I.
- E. Expansion Joint Material: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal. Wood is not an acceptable joint material.
- F. Horizontal Joint Sealants: Conforming to ASTM C920, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are MasterSeal SL1 or SL2, Dow Corning 890-SL, Sikaflex -1c SL or approved equal.

- G. Vertical Joint Sealants: Conforming to ASTM C920, non-priming, gunnable, non-sag polyurethane. Acceptable sealants are MasterSeal NP1 or NP2, Dow Corning 888, or approved equal.
- H. Aggregate: Shall conform to ASTM C33.
- I. Water: Shall be clean and potable
- J. Dowel Bars: Shall conform to ASTM A615, grade 60, and plain steel bars.
- K. Air Entraining Mixture: Shall conform to ASTM C260 (Sika AER by Sika Corporation, Air Mix by the Euclid Chemical Corporation or approved equal).
- L. Curing Compound: Shall conform to ASTM C309 (Hydrocide by Sonneborn or Rexnord Chemical Products, Inc., and Polyseal 4 in 1 by Chem Masters Corporation or approved equal.
- M. Joint Backup Rods: Shall be CCEVA Rod 100 by E-Poxy Industries, Inc., Sealtight BACKER ROPE by W.R. Meadows, Inc. or approved equal.
- N. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, non-fading, and resistant to lime and other alkalis.
- O. Product Standard: L.M. Scofield Company "Chromix" admixture
- P. Color: As selected by Architect from manufacturer's full range.
- Q. Fly Ash: Class F, no more than 20%

2.2 MIX DESIGN AND TESTING

- A. Mix concrete and deliver in accordance with ASTM C94.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following properties:
 - 1. Compressive Strength: 4,000 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings or Geotechnical Report.
 - 2. Slump Range: 2"-4" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete
 - 3. Air Entrainment: 3 to 6 percent

PART 3 EXECUTION

3.1 PREPARATION

- A. Proofroll prepared subgrade material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.
- B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

- A. Form Construction
 - 1. Set forms to required grades and lines, rigidly braced and secured.
 - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
 - 3. Check completed formwork for grade and alignment to following tolerances:
 - a. Top of forms not more than 1/8-inch in 10'-0"

- b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0"
 4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
- C. Concrete Placement
 1. Concrete may be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising. Hot and cold weather concreting shall be in accordance with ACI 305R and 306R, respectively.
 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at required finish elevation and alignment.
 3. Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint.
- D. Joint Construction: Construct expansion, weakened-plane control (contraction), and construction joints straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline, unless otherwise detailed.
 1. Weakened-Plane Control or Contraction Joints: Provide joint spacing layout per American Concrete Pavement Association (ACPA) Technical Paper No. IS061P "Design and Construction of Joints for Concrete Streets" and submit joint layout plan to engineer for approval. Construct control joints for depth equal to at least 1/4 of the concrete thickness on 10' centers E.W. Align joints in adjacent pavement and structures.

*Additional joints will be necessary for non-standard applications (parking islands, structures, inlets, manholes, etc.)

 - a. Submit Joint Layout Plan for Review/Approval
 - b. Contact the American Concrete Pavement Association (ACPA) at 1 (847) 966-2272, e-mail at acpa@acpa.org, or at 9450 Bryn Mawr, Suite 150, Rosemont, IL 60018.
 - c. Form tooled joints in fresh concrete by grooving top with recommended tool and finishing edge with jointer.
 - d. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
 2. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour, except where such placements terminate at expansion joints. Construct joints in accordance with standard details.
 3. Expansion Isolation Joints: Locate expansion isolation joints at maximum of 500 lf on centers, unless otherwise shown on the Construction Drawings. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, sidewalks, and other fixed objects.

- 4. Butt Joints: For joints against existing pavement, place 16" long dowels eight inches into holes drilled into center of existing slab. Epoxy dowels into holes with approved epoxy compound. Place dowels prior to concrete placement for new concrete. Dowel spacing to be 24" on center unless otherwise shown on Construction Drawings. Saw joint and fill with joint sealer.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, except within 1/2-inch to 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.
- F. Joint Sealants: Joints shall be sealed with approved exterior pavement joint sealants and shall be installed in accordance with manufacturer's recommendations. Sealants for horizontal joints shall be the self-leveling type.

3.3 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of slabs and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
 - 1. Inclined Slab Surfaces: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic so as to produce regular corrugations not over 1/16 of an inch deep.
 - 2. Paving: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic so as to produce regular corrugations not over 1/16 of an inch deep.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Owner.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

3.4 CLEANING AND ADJUSTING

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

3.5 FIELD QUALITY CONTROL

- A. Unless otherwise stated in the Contract Documents, field quality control tests will be conducted by the Owner's Independent Testing Laboratory at no cost to the Contractor in accordance with a testing program recommended by the Owner's contracted Laboratory. Retesting required as a result of failed initial tests shall be at the Contractor's expense unless otherwise stated in the Contract Documents. Written results of all field quality control testing shall be provided to both the Owner and to Adams Engineering.
- B. Unless otherwise directed by the Owner's Independent Testing Laboratory, the contracted laboratory will randomly core pavement at minimum rate of 1 core per 20,000 sq. ft of pavement, with minimum of 3 cores from heavy-duty areas and 3 cores from light duty areas.

Core will be tested for thickness and quality of aggregate distribution. Core holes shall be patched immediately with portland cement concrete and shall be finished to provide level surface as specified herein.

- C. Deficiencies shall be resolved in accordance with the Construction Contract. Refer to the most current edition of the North Central Texas Council of Governments (NCTCOG) standard specifications, Item 105.2 Workmanship, Warranties and Guarantees, Item 105.9 Inspection, and Item 303.8 Pavement Testing and Elevation, to settle any disputes.

END OF SECTION

SECTION 32 1613

CURBS AND SIDEWALKS

PART I GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Preparation and placement of combination concrete curb and gutter.
- B. Preparation and placement of concrete sidewalk.

1.2 RELATED SECTIONS

- A. Section 31 2300 – Excavation and Fill
- B. Section 32 1216 – Asphalt Paving
- C. Section 32 1313 – Concrete Paving
- D. Section 32 1723 – Pavement Markings
- E. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
 - 1. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - 2. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. 305R Hot Weather Concreting
 - 4. 306R Standard Specification for Cold Weather Concreting
 - 5. 308 Standard Practice for Curing Concrete
- B. American Standards for Testing and Materials (ASTM) latest edition
 - 1. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 2. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
 - 3. C33 Concrete Aggregates
 - 4. C78 Method for Flexural Strength Concrete (Using Simple Beam with Third-point Loading)
 - 5. C94 Ready-Mixed Concrete
 - 6. C143 Method for Slump of Hydraulic Cement Concrete
 - 7. C150 Portland Cement
 - 8. C171 Sheet Material for Curing Concrete
 - 9. C231 Air-Content of Freshly Mixed Concrete by the Pressure Method
 - 10. C260 Air-Entraining Admixtures for Concrete
 - 11. C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 12. C494 Chemical Admixtures for Concrete
 - 13. D994 Preformed Expansion Joint Filler for Concrete (Bituminous)
 - 14. D1190 Concrete Joint Sealer, Hot Poured, Elastic Type
 - 15. D1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 - 16. D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- C. State Highway Department Standard Specifications

1.4 QUALITY ASSURANCE

- A. Establish and maintain required lines and elevations.
- B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner.

1.5 SUBMITTALS

- A. Submit materials certificate which materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein to the Engineering Consultant of Record and the independent testing laboratory for review and approval. Within 7 calendar days after receipt of Notice-to-Proceed, submit for approval, certified laboratory test data or manufacturers certificates and data for the following items:
 - 1. Portland cement concrete mix
 - 2. Aggregate gradations
 - 3. Preformed expansion joint filler
 - 4. Field molded/poured sealant
 - 5. Dowel bars
 - 6. Expansion sleeves
 - 7. Tie bars
 - 8. Reinforcing steel bars
 - 9. Welded wire fabric
 - 10. Air entraining admixtures
 - 11. Water-reducing and set-retarding admixtures (if used)

1.6 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets.
- C. Reinforcing Steel: Deformed steel bars, ASTM A 615, Grade 60.
- D. Portland Cement: Shall conform to ASTM C150, Type I.
- E. Expansion Joint Material: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal. Wood is not an acceptable joint material.
- F. Horizontal Joint Sealants: Conforming to ASTM D1190, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are MasterSeal SL1 or SL2, Dow Corning 890-SL, Sikaflex -1c SL or approved equal.

- G. Vertical Joint Sealants: Conforming to ASTM C920, non-priming, gunnable, non-sag polyurethane. Acceptable sealants are MasterSeal NP1 or NP2, Dow Corning 888, or approved equal.
- H. Aggregate: Shall conform to ASTM C33.
- I. Water: Shall be clean and potable
- J. Dowel Bars: Shall conform to ASTM A615, grade 60, and plain steel bars.
- K. Air Entraining Mixture: Shall conform to ASTM C260 (Sika AER by Sika Corporation, Air Mix by the Euclid Chemical Corporation or approved equal).
- L. Curing Compound: Shall conform to ASTM C309 (Hydrocide by Sonneborn or Rexnord Chemical Products, Inc., and Polyseal 4 in 1 by Chem Masters Corporation or approved equal.
- M. Joint Backup Rods: Shall be CCEVA Rod 100 by E-Poxy Industries, Inc., Sealtight BACKER ROPE by W.R. Meadows, Inc. or approved equal.
- N. Fly Ash: Class F, no more than 20%.

2.2 MIX DESIGN AND TESTING

- A. Mix concrete and deliver in accordance with ASTM C94.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following:
 - 1. Compressive Strength: 3,600 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings or Geotechnical Report.
 - 2. Slump Range: 2"-4" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete
 - 3. Air Entrainment: 3 to 6 percent

PART 3 EXECUTION

3.1 PREPARATION

- A. Proofroll prepared base material surface to check for unstable areas. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving.
- B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

- A. Form Construction
 - 1. Set forms to required grades and lines, rigidly braced and secured.
 - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
 - 3. Check completed formwork for grade and alignment to following tolerances:
 - a. Top of forms not more than 1/8-inch in 10'-0"
 - b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0"
 - 4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.

- C. Concrete Placement
1. Concrete may be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising. Hot and cold weather concreting shall be in accordance with ACI 305R and 306R, respectively.
 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until set at required finish elevation and alignment.
 3. Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified herein.
- D. Joint Construction
1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by steel templates, 1/8-inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2-inches below surface of curb and gutter; or with 3/4-inch thick preformed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2-inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold it's shape, but shall be removed while forms are still in place.
 2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
 3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.
- F. Joint Sealants: Seal joints with approved exterior pavement joint sealants. Install in accordance with manufacturer's recommendations. Sealants for horizontal joints shall be the self-leveling type.

3.3 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:

1. Curbs and gutters: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed Owner.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

3.4 BACKFILL

- A. After concrete has set sufficiently, spaces on either side of concrete curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with Section 31 2300.

3.5 CLEANING AND ADJUSTING

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION

SECTION 32 1723

PAVEMENT MARKINGS

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Preparation and application of painted parking lot pavement markings.
- B. Preparation and application of paint on curbs, guard posts, and light pole bases.

1.2 RELATED SECTIONS

- A. Section 32 1216 - Asphalt Paving
- B. Section 32 1313 - Concrete Paving
- C. Section 32 1613 - Curbs and Sidewalks
- D. Construction Drawings

1.3 REFERENCE STANDARDS

- A. Federal Specifications and Standards
 - 1. A_A 2886A Paint, Traffic, Solvent Based (supersedes FS TT-P-85E and FS TT-P-115F, Type I)
- B. American Association of State Highway and Transportation (AASHTO)
 - 1. AASHTO M248 Ready-Mixed White and Yellow Traffic Paints
- C. ASTM D4414-95 (2001): Standard Practice for Measurement of Wet Film Thickness by Notched Gauges.

1.4 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs, and warning lights as required.

1.5 QUALITY ASSURANCE

- A. Use trained and experienced personnel in applying the products and operating the equipment required for properly performed work.
- B. Testing of wet film thickness shall be performed a minimum of two (2) times on each parking row (including striped islands) and pedestrian cross walks, and a minimum of one (1) test on each lane/alignment striping. At least one test shall be performed after refilling paint striping machine, changing operators of striping machine, and changing paint types, brands, etc. (This shall be performed in addition to the testing stated above). These tests shall be performed on each coat applied. Testing shall be per ASTM D4414-95 (2001).

PART 2 PRODUCTS

2.1 MATERIALS

- A. Paint shall be non-bleeding, quick-drying, and alkyd petroleum base paint suitable for traffic-bearing surface and be mixed in accordance with manufacturer's instructions before application for colors White, Yellow, Blue, and Red.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine the work area and correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Sweep and clean surface to eliminate loose material and dust.
- B. Where existing pavement markings are indicated on Construction Drawings to be removed or would interfere with adhesion of new paint, a motorized abrasive device shall be used to remove the markings. Equipment employed shall not damage existing paving or create surfaces hazardous to vehicle or pedestrian traffic. Within public rights-of-way, appropriate governing authority shall approve method of marking removal.
- C. New pavement surfaces shall be allowed to cure for a period of no fewer than 30 days before application of marking materials.

3.3 APPLICATION

- A. Apply two (2) coats of paint at manufacturer's recommended rate, without addition of thinner, with maximum of 100 square feet per gallon or as required to provide a minimum wet film thickness of 15 mils and dry film thickness of 7 ½ mils per coat. Paint shall be applied for a total dry film thickness of 15 mils. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use straightedge to ensure uniform, clean, and straight stripe.
- B. Install pavement markings according to manufacturer's recommended procedures for the specified material.
- C. Following items shall be painted with colors noted below:
 - 1. Pedestrian Crosswalks: White
 - 2. Guard posts and Bollards: Yellow or as specified by owner
 - 3. Fire Lanes: Red with White lettering or per local code
 - 4. Lane Striping where separating traffic moving in opposite directions: Yellow
 - 5. Lane Striping where separating traffic moving in the same direction: White
 - 6. Handicap Symbols and Access Aisles: Blue/White as detailed or per local code
 - 7. Parking Stall Striping: White, unless otherwise noted on Construction Drawings

3.4 INSPECTION AND CLEAN UP

- A. Refer to Part 1 (Quality Assurance).
- B. After the paint has thoroughly dried, visually inspect the entire application and touch up as required to provide clean, straight lines and surfaces throughout.
- C. Waste materials shall be removed at the end of each workday. Upon completion of the work, all containers and debris shall be removed from the site. Paint spots upon adjacent surfaces shall be carefully removed by approved procedures that will not damage the surfaces and the entire job left clean and acceptable.

END OF SECTION

SECTION 32 8000

IRRIGATION SYSTEMS

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Installation of underground, automatically controlled lawn and shrub bed irrigation system, including electrical connections, connections to water mains, and necessary code compliant accessories.
- B. Furnishing all work and materials, appliances, tools, equipment, facilities, transportation, and services necessary for and incidental to performing all operations in connection with the installation of underground irrigation system complete, as shown on drawings and/or specified herein. When the term "Contractor" is used in this section, it shall refer to the irrigation Subcontractor.
- C. Provide and execute Extended 2-Year Maintenance Agreement.

1.2 RELATED SECTIONS

- A. Section 31 2300 – Excavation and Fill
- B. Section 33 1100 - Water Distribution Systems
- C. Section 32 1216 – Asphalt Paving
- D. Section 32 1313 – Concrete Paving
- E. Section 32 9000 - Planting
- F. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
 - 1. D2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
 - 2. D2241 Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
 - 3. D2564 Solvent Cement for poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
 - 4. D2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
 - 5. D2855 Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- B. National Fire Protection Agency (NFPA) latest edition
 - 1. 70 National Electrical Code (NEC)

1.4 QUALITY ASSURANCE

- A. Report to the Irrigation consultant any deviations between the irrigation plan, technical specifications, and the site which may cause issues with inadequate or excessive coverage and/or general performance of the system. Failure to do so prior to installation of equipment which subsequently requires replacement, relocation, or modification shall be done solely at the Contractor's expense.
- B. All local, municipal, and state laws, ordinances, codes and regulations relating to, or governing of, any portion of this work are hereby incorporated into and made a part of these specifications and shall be fully carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules, regulations, and requirements. However, when these specifications and drawings call for or describe

materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, these specifications and drawings shall take precedence.

- C. Permits needed for construction of the work included in this contract which are required by any legally constituted authority having jurisdiction, shall be obtained. Contractor shall pay for all costs in connection with permits and inspections required by such authorities. The Owner's representative shall be notified when these inspections are required. Any additional work to be done as a result of these inspections shall be performed at the Contractor's expense.
- D. Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturers of components used in this system furnish directions covering points not shown in the drawings and specifications.
- E. Due to the scale of the drawings and nature of the work, it is not possible to indicate all offsets, fittings, pipe sizing, etc., which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all work and plan work accordingly to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between system performance and the development as a whole.
- F. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is questionable in the field that obstructions, grade differences or discrepancies exist that might not have been considered in the design. Such obstructions or differences should be brought to the attention of the Owner's representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revisions necessary.
- G. Perform piping installation in accordance with Section 33 1100 or as specified on the Construction Drawings.
- H. Following installation, make final adjustments to lawn irrigation system prior to Owner's final inspection.
 - 1. Flush system completely, with nozzles and screens removed, to extract debris.
 - 2. Verify sprinkler operation and alignment for direction of throw. Correct as necessary at no additional cost to the Owner.
 - 3. Check pop-up spray nozzling for proper arc of spray with no overthrow onto pavement. Adjust nozzles as necessary for proper throw with no additional cost to the Owner.
 - 4. Insure uniform distribution exists.
 - 5. Insure proper sprinkler head operation after landscaping and/or sod installation.
- I. Following final adjustment, operate entire installation to demonstrate complete and successful operation of equipment. Programming / operation of the system which exceeds manufacturer's recommendations voids all design responsibility to the Irrigation consultant.
- J. The Guarantee (warranty) submitted under this specification shall not deprive the Owner of other rights or remedies that the Owner may have under other provisions of the Contract Documents and is in addition to and is in force concurrently with other warranties made by the Contractor under requirements of the Contract Documents. Installation shall be warranted for 1 year from date of final acceptance for the following:
 - 1. Defects in material, equipment, and workmanship of materials.
 - 2. Manufacturer warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.
 - 3. Activities with no additional costs to Owner shall include and completed at regular time intervals as agreed upon by both Contractor and Owner:
 - a. adjusting irrigation heads and valve boxes level to finish grade,
 - b. adjusting heads perpendicular to the finish grade,
 - c. filling trenches that have settled 1" or more,

- d. compacting soil firmly around heads and valve boxes.
- 4. Repair of damage to premises resulting from leaks or other defects in material, equipment, and workmanship to satisfaction of Owner.
- 5. Required warranty coverage does not include alterations to the system necessitated by additional landscaping, tree planting, grading, or changes to pavement or structures after final acceptance of the project by the Owner.
- K. Basis of Payment:
 - 1. The irrigation system includes the required installation of control systems, pumping systems, accessory and operating equipment that must include all materials, installation labor, overhead/profit and the cost of required warranty and record documents. This system shall be bid as a lump sum price with a unit price schedule accompanying such bid.

1.5 SUBMITTALS

- A. Component Submittal:
 - 1. Do not proceed with purchase or installation of materials prior to receipt of approved submittals from Owner.
 - 2. Provide 1 digital set containing one logically organized copy of each component as specified per plan and/or herein for system designer to review.
 - 3. Material list shall include the manufacturer, model number, and description of all materials to be used.
 - 4. Each submittal set shall include a cover page to accept approval stamps and include the submittal number, project type, project location, contractor name and contact.
 - 5. Equipment or materials installed or furnished without prior approval of the designer may be rejected and required to remove such materials from the site at the Contractor's expense.
- B. Substitutions shall be made only with written approval of Owner. This is not intended to unduly restrict competitive procurements or bidding, but is done to assure a minimum standard of quality which is believed to be best for the item specified and to match existing equipment. Substitutions will not be considered prior to opening of bids.
 - 1. Substitutions shall include descriptive catalog literature, performance charts and/or flow charts.
 - 2. Each substitution proposed shall include a written statement indicating the differences of operation and performance.
 - 3. Substitution of specified irrigation heads after awarding of bid shall require piping diagram noting revised pipe sizes, pressure loss calculations, and head locations necessary to achieve desired watering provided by system as shown on Construction Drawings.
 - 4. Provide digital set of product data for requested substitution to Owner for review.
- C. Static and Dynamic Water Pressure Test.
 - 1. These tests are required with results provided to Irrigation consultant. The water source for this project is indicated on the Construction Documents. The static pressure (if known) and necessary design pressure are also provided thereon.
 - 2. If the pressure reading obtained by the Contractor is different than indicated and can not satisfy the necessary design pressure, contact the Irrigation consultant immediately before proceeding or ordering of equipment. Failure to do so will hold the Contractor solely responsible for required alterations to the system to fit the available water source.
- D. Project Record Documents and Final Punchlist
 - 1. Provide complete Project Record Documents to Irrigation consultant for review and use in Final Punchlist. All documents will be returned to Contractor with Final Punchlist for "walk through" with the Owner of the irrigation system.

2. Within ten (10) days of receipt to the office responsible for irrigation design, Irrigation consultant shall attempt to perform Final Punchlist and submit written response within four (4) days of the inspection to the Prime consultant.
- E. Written Warranty: Provided to Owner which meets or exceeds the requirements under QUALITY ASSURANCE.
- F. Spare Parts: The Contractor shall supply the Owner with five spray heads, one for each head type designated on the plan. The Contractor shall supply one additional key and hose swivel for the quick coupler.

1.6 PROJECT RECORD DOCUMENTS

- A. As-built drawings: 2 sets, noting actual system pressure and exact locations and changes in a different color to the Construction Drawings.
 1. Include dimensional locations of each major component noted below from two (2) permanent fixed points such as building corners, light poles, fire hydrants, manholes, etc.
 2. Minimum components to be located and dimensioned include:
 - a. Point of connection, meter, isolation valve, backflow device, pressure pump.
 - b. Irrigation mainline alignment and sleeving.
 - c. Isolation gate valves and quick coupling valves.
 - d. Control (electric) wire splice boxes and routing.
 - e. Air and vacuum relief valves.
 3. Installation shall be recorded daily on plan sheets appropriately scaled and available for review by the Owner's representative.
- B. Operation Manual: 2 copies, bound in three ring binders, indexed and tabbed for easy reference, and labeled on spine and cover. Manual is to include following:
 1. Installing company name, address, phone/fax number, and list of principal owner(s).
 2. Material suppliers name, address, phone/fax number.
 3. Checklist: (using the following format)
 - a. Plumbing permits: (if none required, so note)
 - b. Material approvals: (approved by and date)
 - c. Pressure line tests: (by whom and date)
 - d. Record Drawings: (approved by and date)
 - e. Controller charts: (approved by and date)
 - f. Materials furnished: (received by and date)
 - g. Operation and maintenance manuals: (reviewed by and date)
 - h. System and equipment operation instructions: (reviewed by and date)
 - i. Manufacturer's warranties if required: (received by and date)
 - j. Written guarantee: (received by and date)
 4. Approved submittals as specified herein.
 5. Operating Instructions:
 - a. Winterization procedures
 - b. Recommended operation sequence, frequency, and length of operation cycle, as per relationship to estimated soil infiltration rate / absorption rate, evaporation rate, and anticipated flow.
 6. Maintenance Instructions:
 - a. Manufacturers' product data, installation, and maintenance instructions that list and recommend frequency of service to specific components.
 - b. Parts Manufacturers' warranties for all equipment installed shall be provided to Owner.
 - c. Copies of completed warranty information. Contractor to complete and mail necessary warranty registration information to manufacturer with copies provided to Owner.
 - d. Provide a Maintenance Checklist containing the signature of the irrigation system owner or Owner's representative, the irrigator's seal, signature and date, and a statement confirming that "The irrigation system has been

installed in accordance with applicable state and local laws, ordinances, rules, regulations or orders. I have tested the system and determined that it has been installed according to the Irrigation Plan and is properly adjusted for the most efficient application of water at this time “.

- C. Controller Chart: Prepare color coded chart, reduced in size, containing same plan information as As-Built drawings, and laminated in plastic on both sides, with following specific information:
 - 1. Note routing of control wires.
 - 2. Identify valves as to size, station number shown on controller, and type of irrigation head (e.g. spray, rotor, drip) on each valve.
 - 3. Delineate each station's limits of coverage by color-coding, with each station having different color showing its zone with zone number designation.
- D. Copies of necessary permits and inspection tags to justify governing approvals.

1.7 PROJECT CONDITIONS

- A. Visit site and become familiar with nature and location of work, existing conditions, and conditions that will exist during installation.
- B. If irrigation work is part of General Construction Contract, then meter and backflow device shall be provided and permitted by Utility Subcontractor in accordance with Section 33 1100. If irrigation work is not part of General Construction Contract, General Contractor shall contract with and pay local utility company, including meter deposit, to tap water main and install meter(s) required. Backflow device shall be provided and permitted as described herein.
- C. Electric power shall be provided within five feet of each controller location by the prime General Contractor. The irrigation contractor shall provide final hardwire connection. Verify and coordinate necessary electrical and phone connections for system operation.
- D. Existing Utilities:
 - 1. Locations and elevations of various utilities included with the scope of this work have been obtained from the most reliable sources available and should serve as a general guide without guarantee to accuracy. Contractor shall examine the site and verify to own satisfaction the locations and elevation of all utilities and availability of utilities and services required. The Contractor shall inform himself as to their relation to the work and the submission of bids shall be deemed as evidence thereof.
 - 2. Should utilities not shown on the plans be found during excavations, Contractor shall promptly notify the Owner for instructions as to further action. If damaged, the Contractor shall repair at his own expense, and to the satisfaction of the Owner any utility shown or not shown on the plans.
 - 3. Contractor shall make necessary adjustments in the layout as may be required to connect to existing service stubs that may not be located exactly as shown at no increase in cost to the Owner. All such work will be recorded on record drawings.
- E. Any irrigation work surrounding preserved vegetation shall closely follow the layout as presented on the plans except when it is purposely shown in a hardscape area for graphic clarity. If the planned preservation area is considered threatened, full irrigation coverage may not be shown or warranted.

1.8 QUALIFICATIONS

- A. The installation of the irrigation system shall be made by an individual or firm duly licensed under Article No. 8751 VTCS, Titled "Licensed Irrigators Act", S.B. No. 259 as passed by the 66th Texas Legislature.

- B. Licensed irrigation contractor shall be in good standing of the governing state agency with a minimum 5 consecutive years experience in area of project and having installed other jobs of similar size and scope with verifiable post-installation warranty performance.
- C. The irrigation foreman installing the project must attend the pre-construction meeting to coordinate with associated trades and review the plans and specifications. Irrigation foreman shall also remain on the project throughout installation until Substantial Completion has been issued for the system. Failure to maintain this individual on the project site without Owner approval, excluding events beyond control (health, resignation, etc.) will subject installing contractor to a one-time penalty of \$5,000 to be deducted from the contract retainage.
- D. Provide minimum of 3 references and list of similar projects with owner's names, addresses, and telephone numbers, when requested by Owner.

1.9 MAINTENANCE

- A. Once each month, for first 6 months of operation following Final Acceptance, provide on-site consultation with Owner's operating personnel. This shall include up to 4 hours time each month.
- B. Maintenance agreement:
 - 1. Prior to beginning installation, execute bonded, written Extended 2-Year Maintenance Agreement with Owner for period of 2 years from date of Final Acceptance for the following:
 - a. Spring start-up of system in accordance with Section 32 9000.
 - b. Monthly checks of system during operating season.
 - c. Winterization of system in accordance with Section 32 9000.
 - 2. Costs for additional work required for repair of items not covered by warranty (e.g. damage by others) shall be negotiated between Owner and Contractor prior to initiation of any repairs.
 - 3. Costs for Extended 2-Year Maintenance Agreement are over and above Contract Sum, and shall not be included in construction price. Payment for extended maintenance by Owner shall occur upon completion of scheduled service and additional work, if any, as it occurs on monthly basis throughout duration of Extended 2-Year Maintenance Agreement.

PART 2 PRODUCTS

2.1 GENERAL

- A. Unless otherwise noted on the plans, all materials shall be new and unused. The irrigation equipment catalog numbers used for reference are to establish minimum quality standards and may be substituted with an "approved similar" as outlined in Section 1.5.
- B. Acceptable manufacturers of specialized components shall include:
 - 1. RainBird Corporation
 - 2. HUNTER Industries, Inc.
 - 3. NETAFIM USA
 - 4. Owner Approved two-wire and/or central control providers

2.2 PIPE

- A. Marking and Identification: PVC pipe shall be continuously and permanently marked with following information: Manufacturer's name, size, type of pipe, and material, SDR number, Product Standard number, and the NSF (National Sanitation Foundation) Seal.
- B. Polyvinyl Chloride (PVC): Shall conform to ASTM D2241
 - 1. Mainline pipe shall be Sch. 40.
 - 2. Lateral pipe shall be Class 200 solvent weld, SDR 21, PS 22 70 for all sizes 3/4 inch to 3 inches.

- 3. All 1/2 inch pipe shall be solvent weld SDR 13.5, Class 315.
- C. Flexible Polyethylene (PE): Pipe shall conform to ASTM D2239, SDR 11.5, PE23, rated at 100 PSI, National Sanitation Foundation (NSF) approved. Subject to approval of Owner, shall be utilized for laterals in areas where ground is subject to freezing for extended periods of time each year.
- D. Pipe sizes 2 1/2-inch or smaller shall have bell and socket joints that are solvent welded.
- E. Pipe sizes larger than 2 1/2-inch shall have snap connections with rubber gasket joints. Thrust blocking shall be required in accordance with Section 32 1100.
- F. Sleeves: Pipe used to sleeve below paved areas shall conform to ASTM D2241, Schedule 40. Minimum diameter of 2-inch or 2 sizes larger than pipe scheduled to pass through the sleeve.

2.3 FITTINGS

- A. Pipe Fittings:
 - 1. Polyvinyl Chloride (PVC) Fittings: Fittings shall conform to ASTM D2241, Schedule 40, and Molded.
 - 2. Flexible Polyethylene (PE) Lateral Line Fittings: Fittings shall conform to ASTM D2609, Type 1 PVC insert fittings designed for used with this type of pipe. Pipe and fittings shall be joined with stainless steel pinch clamps or worm gear clamps, including stainless steel screw.
 - 3. Risers above finished grade shall be black in color or receive 2 coats of black exterior semi-gloss enamel paint if a color other than black.
- B. PVC Primer Solvent and Cement: Pipe and fittings shall be primed with a colored primer prior to applying PVC cement in accordance with the Uniform Plumbing Code (Section 316) or the International Plumbing Code (Section 605). Cement shall conform to ASTM D2564.
- C. Swing Pipe Connections: Connections between spray heads to lateral piping shall be thick wall, flexible, polyethylene pipe, with fittings that have male thread on one end and either male or female screw ends opposite. Glue fittings and female barb adapters are not allowed.
- D. Swing Joint Connections: Connections between quick couplers to mainline; and rotor heads to lateral piping shall be rigid PVC with fittings that have street ells on each end.

2.4 BALL VALVES - 3-Inches or Smaller

- A. Cut off or isolation valves shall be as manufactured by LASCO or approved equal.

2.5 MECHANICAL JOINT VALVES - Larger than 3-Inches

- A. Cut off or isolation valves shall be of cast iron and bronze construction and have fusion bonded epoxy coated, exterior and interior, finish as Resilient Wedge Valve, manufactured by Clow Valve Co., Oskaloosa, Iowa or approved similar.
- B. Provide with each valve a valve key and cast iron cylindrical valve box with top.

2.6 QUICK COUPLER VALVES

- A. Each with key having 3/4-inch male top pipe threads for hose connection, shall be one of following:
 - 1. Rain Bird model 44LRC Valve with key
 - 2. HUNTER model HQ-3RC Valve with model HK-33 Key

2.7 ELECTRIC CONTROL VALVES

- A. Electric remote control valves shall have plastic bodies and covers and shall be globe type diaphragm valves of normally closed design. Acceptable or approved similar valves include: Rain Bird PEB Series or HUNTER ICV electric remote control valves
- B. A master valve if indicated on the Construction Drawings shall be sized to diameter of leading mainline pipe and installed on the discharge side of the backflow prevention device and/or pressure pump system.

2.8 SPRINKLER HEADS

- A. Full or part Circle Pop-Up Fixed Spray Sprinkler:
 - 1. If not specified on Construction Drawings, pop-up heights shall be:
 - a. Turf - 4-inches
 - b. Shrub and groundcover beds - 12-inches
 - 2. Acceptable Products:
 - a. Rain Bird 1800 Series Matched Precipitation Rate (MPR) nozzles and/or High Efficiency (HE) Variable Arc Nozzles (VAN) with 1800 Series Pressure Regulating (PRS) sprinklers.
 - 1) Low point heads shall include Seal-A-Matic (SAM) to control drainage.
 - 2) Non-potable systems shall include RD 1800 Series sprinklers.
 - b. HUNTER Adjustable Arc Series nozzles or Pro-Spray Series nozzles with INST Series sprinklers having in-stem built-in pressure regulation and Check Valve (CV) features.
- B. Full or Part Circle Pop-up Gear Driven Rotor Sprinkler.
 - 1. Acceptable Products:
 - a. Rain Bird Turf Bird Rotor Pop-up Sprinkler Series, 5000 MPR Series, 5500 Series short radius nozzles, or 6504 Series, with rain curtain nozzles and Seal-A-Matic (SAM) check valve as needed.
 - b. HUNTER Rotor PGP Series, I-20 or I-25 Series, or I-35 Series, with appropriate nozzles and check valve features.

2.9 DRIPPERLINE AND INTEGRAL DRIPPERLINE COMPONENTS

- A. The dripperline shall be Techline CV or Techline pressure compensating dripperline as manufactured by Netafim Irrigation, Inc. Dripper flow rate and spacing shall be as recommended by application.
 - 1. Techline CV/Techline RW/Techline/Fittings: All Techline CV/Techline RW/Techline connections shall be made with approved Techline CV/ Techline RW/Techline insert fittings.
 - 2. Soil Staples (TLS6): All on-surface/under mulch Techline CV/ Techline RW/Techline installations shall be held in place with Techline Soil Staples spaced evenly every 2' - 5' on center, and with two staples on each change of location.
 - 3. Line Flushing Valves: All Techline systems shall be installed with Netafim Automatic Line Flushing Valves as recommended. Techline CV zones do not require an automatic line flushing valve but must have a manual flushing port(s) in the position that an automatic flush valve would be positioned.
 - 4. Air/Vacuum Relief Valves: Each independent Techline subsurface irrigation zone shall be installed with an Air/Vacuum Relief Valve at the zone's highest point(s). Techline CV zones do not require an Air/Vacuum Relief Valve.
 - 5. Pressure Regulator: A pressure regulator shall be installed at each zone valve or on the main line to ensure operating pressures do not exceed system requirements. The pressure regulator shall be a Netafim Pressure Regulator, model number as recommended.

6. Manual Disc Filter: A disc filter shall be installed at each zone valve or on the main line to ensure proper filtration. The filter shall be a Netafim Disc Filter, model number and mesh as recommended.

2.10 VALVE BOX

- A. Valve boxes shall be manufactured by Ametek or approved similar. No irrigation valve box shall be placed in pavement areas unless otherwise specified on the Construction Drawings.
 1. When used with single valve, provide Economy Turf Box with green colored locking cover.
 2. When used with 2 or more valves, provide Jumbo Box with 20-inch x 14-inch green locking cover opening with cover labeled "Control Valve".
 3. When used for wire splice or isolation valve, provide round box with snap fit cover.
 4. When used for quick coupler devices, provide Economy Turf Box with purple colored locking cover.

2.11 LOW POINT DRAINS

- A. Automatic drain valves shall be Rain Bird Model Number 16A, FDV, or approved equal.
- B. Provide two (2) valves at lowest points of each zone as dictated by climate, with each drain installed above a 12-inch x 12-inch x 12-inch deep area of coarse gravel.

2.12 AUTOMATIC CONTROLLER

- A. Operation of the controller shall be full automatic, incorporating one 24 hour clock and 14 day calendar per controlled number of electric valves shown on the plan to start the sprinkling cycle any hour or hours of the day or night of any day or days over a repeating 14 day period.
- B. The controller shall be capable of repeating watering cycles as required with a maximum delay between the ending of one cycle and the beginning of the next not to exceed 2 hours. Control shall provide optional semi automatic operation whereby the automatic cycle may be started independent of the clock and manual operation whereby any station may be operated by hand independent of all timing mechanism. The choice of automatic day or hour programming shall be available to the operator on the face of the control panel without the use of tools.
- C. Controller shall have wall mount, weatherproof, lockable cabinet with internal transformer capable of operating the number of zones indicated. Acceptable products include:
 1. Rain Bird ESP-Modular or ESP-MC Series
 2. HUNTER PRO-C or ICC Series
- D. Power source shall be 110v A.C. Output for operation of companion solenoid actuated valves shall be 24 volts 60 Cycle AC.
- E. Electrical grounding shall be accomplished with any combination of below grade rods and/or plates connected with #6 AWG or larger solid bare copper wire to obtain a maximum ground resistance of 10 ohms or less.
 1. Grounding Rods: 5/8" diameter x 8-foot long copper clad
 2. Grounding Plate: minimum 4" x 96" x .0625" copper clad

2.13 WIRE

- A. It shall be the responsibility of the Contractor to furnish and install the proper size wire on each of the low voltage circuits from the master control center to the various electric remote control valves. Under no circumstances shall the voltage of any branch circuit be reduced

more than proper due to length of run exceeding the maximum allowable for the wire size used.

- B. All valve wire shall be single strand solid copper, minimum 14 gauge with type UF insulation which is Underwriters Laboratory approved for direct underground burial when used in a National Electrical Code Class II Circuit (30 volts AC or less) as per Articles 725 and 300.
 - 1. Colored control wire shall have same color-coding as visible in controller. Should multiple controllers be required, each controller shall utilize a unique color insulated wire.
 - a. Provide single wire and common neutral from controller to each valve.
 - b. Approved two-wire systems shall conform to manufacture installation guidelines.
 - 2. Connectors: No wire splices shall be buried.
 - a. All connectors shall be UL listed, rated 600 volt, for PVC insulated wire.
 - b. Wire connectors shall have a two piece PVC housing which, when filled with resin epoxy and pressed together, forms a permanent, one piece, moisture proof wire splice.
- C. All 110 volt (or larger) wire required for this project shall be material as required by local code and installed to local code.

2.14 CLIMATE SENSOR

- A. Provide rainfall sensor to cancel operation of controller during substantial rainfall. Acceptable products include:
 - 1. Mini-Click Rain Sensor manufactured by Hunter
 - 2. Approved equal as manufactured by entities specified in 2.01 above and controller compatible.
- B. Provide freeze sensor to cancel operation of controller during low temperatures that could endanger the system, plant material, or general public. Acceptable products include:
 - 1. Freeze-Click Freeze Sensor manufactured by Hunter
 - 2. Approved equal as manufactured by entities specified in 2.01 above and controller compatible.

2.15 BACKFLOW PREVENTOR

- A. Comply with requirements and codes of the state and local governing authority regarding backflow prevention.
- B. Provide the necessary materials, insulation/draining capabilities, vandal resistance, permanent foundation and insulated fiberglass enclosure, dark green in color unless otherwise dictated by local code.
- C. Backflow preventer type shall be suitable for use in high hazard cross connection to potable water system as manufactured by Watts Regulator Company, Lawrence, Ma., or approved similar:
 - 1. Reduced Pressure Backflow preventers shall be No. 909 series, or approved similar.
 - 2. Pressure Vacuum Breaker assembly or approved similar.
 - 3. Double Check Valve assembly backflow preventers shall be No. 709 series, or approved similar.
 - 4. In absence of local codes or requirements, double check assembly backflow preventer installed in strict accordance with manufacturer's written instructions shall be considered as minimum requirements.

2.16 METER

- A. A turbo-style meter and box shall meet or exceed requirements set forth by local utility company.

- B. Installation of the water meter to be completed by the site utility contractor and includes all necessary inspections for local approval.

2.17 VARIABLE SPEED PRESSURE PUMP SYSTEM

- A. Reference design plan for specified pump or performance criteria to satisfy pressure requirements of the irrigation system.
- B. All pressure pump systems shall be installed on a stable concrete foundation with a secured weather / vandal resistant enclosure with sufficient clearance for the selected pump assembly.

PART 3 EXECUTION

3.1 PREPARATION

- A. Pressure/Flow Test: Conduct tests at the irrigation water tap or meter location prior to installation and provide written results to Owner including the following information:
 - 1. Static pressure in psi
 - 2. Residual pressure in psi
 - 3. Flow in gpm
- B. Prior to installation, receive approval from General Contractor to proceed with construction.
- C. Contractor shall field verify all aboveground and underground utilities prior to start of work.
- D. Before trenching of the system is started, flag where each sprinkler head, quick coupler valve, mainline pipe, control valve, etc. to be located in accordance with the plans. Should a discrepancy in the plans become apparent at this time, in regard to size and/or shape of areas to be irrigated, such discrepancy shall be pointed out to the Owner or Owner's representative.
 - 1. Should such changes create an increase or decrease in the Contract amount, the Owner shall approve such change in cost prior to commencement of work.
 - 2. Should the severity of the discrepancy make it necessary to consult the irrigation designer, cease work in the vicinity of the discrepancy until a resolution can be determined.
 - 3. Preserved trees shall be protected from trenching to the minimum extent of the canopy dripline. Should the planned preservation area be threatened by irrigation work, full irrigation coverage may not be warranted.
- E. Traffic control barricades shall be provided as necessary in accordance with state highway barricade standards for the protection of workers, pedestrians, bicycles, and vehicles.
- F. All material shall be installed in accordance with manufacturer's installation specifications and as shown on the drawings.

3.2 BACKFLOW PREVENTOR

- A. Comply with state and local codes for installation of backflow preventer. In absence of local codes, minimum requirements shall be to set in accordance with manufacturer's written instructions.
- B. Provide combination of drains and quick coupler valves to accommodate winterization of entire system by forced air. Submit materials/methods to Owner for consideration and receive approval prior to installation of work.
- C. Contractor shall ensure the backflow prevention device is tested prior to being placed in service and the test results provided to the local water purveyor and the Owner of the irrigation system within 10 business days of testing the backflow prevention device.

3.3 EXCAVATION

- A. Excavate trench to proper depth.
- B. Minimum trench width shall be 3 1/2-inches.
- C. Backfill and hand tamp over excavation prior to installing piping.
- D. Excavate trenches deeper than required in soils containing rock or other hard material that might damage pipe. All excavations and backfill shall be unclassified and covered in the basic bid. No additional compensation will be allowed for rock encountered. Backfill to proper depth with selected fine earth or sand.
- E. Keep trenches free of obstructions and debris that would damage pipe.
- F. Avoid heating trenches, electric ducts, storm and sanitary sewer lines, water and gas mains when trenching for piping.
- G. Do not cut sidewalks, paved areas, or curb and gutter when trenching for piping unless otherwise noted on the Construction Drawings.
 - 1. Provide sleeves (as specified in 2.2 F. above) under paving prior to installation of paving.
 - 2. Under existing paving, auger bore or tunnel without disturbing existing pavement above. Any damaged pavement will be removed and replaced according to specification Section 32 1216 or 32 1313.

3.4 SLEEVING

- A. Conduit from the controller room to the nearest exterior pervious area must include heavy gauge nylon pull cords.
- B. Provide sleeves for both piping and control wiring where either passes under paved surfaces:
 - 1. Depths of sleeves shall be same as that required for piping at each location or condition.
 - 2. Extend sleeves 12-inches beyond paving at each end.
 - 3. Install permanent benchmark at top of curbs for reference to sleeve locations as detailed.

3.5 PIPING INSTALLATION

- A. Inspect all pipe prior to installation. Pay particular attention to mechanical damage resulting from shipment, storage, and defects which might occur during extrusion. Such defective pipe shall be removed from the site at the end of each work day.
- B. Do not lay pipe on unstable material or blocking, or when in opinion of Owner conditions are unsuitable. Rest full length of pipe section on bed of trench, excavating recesses to accommodate joints.
- C. Minimum cover from top of piping to finished grade shall be provided as follows:
 - 1. Lawn and planting areas:
 - a. Mains and Control Valves: Irrigation mains are that portion of piping from water source to electric valves and shall be installed in a trench with a minimum of 18 inches of cover.
 - b. Laterals: Lateral piping is that portion of piping from electrical valve to sprinkler heads and shall be installed in a trench with a minimum of 12 inches of cover.
 - 2. Drives or parking areas: 24 inches
- D. Clearances: Minimum of 3-inches horizontal clearance between parallel lines in same trench or vertical clearance between lines crossing at angles.

- E. Special Requirements - PVC and PE pipe:
 - 1. Snake in trench at least 1-foot per 100-feet of pipe to allow for thermal expansion.
 - 2. Pipe laterals to drain to low point drains located at lowest elevations of each zone.
- F. Threaded Plastic Pipe:
 - 1. Do not use solvent cement on threaded joints.
 - 2. Wrap joints with Teflon tape or use virgin Teflon lubricant so that threads are filled.
- G. PVC Fittings and/or Bell and Socket Pipe: Pipe and fittings shall be primed with a colored primer prior to applying PVC cement in accordance with the Uniform Plumbing Code (Section 316) or the International Plumbing Code (Section 605).
 - 1. Insure a square cut. Burrs at cut ends shall be removed prior to assembly and pipe ends must be tapered (shaved) so that a strong weld will take place.
 - 2. All solvent weld joints must receive color-tinted acetone cleaner/primer prior to solvent application. Apply this material sparingly to the inside of the fittings or pipe so that it does not run down inside the pipe.
 - 3. Apply a uniform coat of solvent to the outside of the pipe with a non-synthetic bristle brush.
 - 4. Apply solvent sparingly to the inside of the fitting in a similar manner using care not to allow the solvent to run down fitting into the pipe.
 - 5. Re-apply a light coat of solvent to the exterior of the pipe and quickly insert the pipe into the fitting.
 - 6. Give the pipe or fitting a quarter turn to insure even distribution of the solvent and make sure the pipe is inserted to the full depth of the fitting socket.
 - 7. Hold in position for a minimum of 15 seconds.
 - 8. Wipe off excess solvent that appears at the outer shoulder of the fitting. The joints shall be allowed to set at least 24 hours before water pressure is applied to the system.
- H. Metal to PVC joint: Install the metal connection first on PVC to metal joints. A non-hardening Teflon paste/tape or Permatex No. 2 shall be used on all threaded PVC to metal joints. Apply only light wrench pressure to tighten.
- I. Concrete thrust blocks and valve anchors: On all irrigation mains (3" and larger) regardless of the joint style used, provide concrete thrust blocks at all changes in direction of the piping and at all cast-iron gate valves. Use 2500 psi minimum strength concrete.
 - 1. Thrust blocks shall be formed by placing concrete between the pipe and an undisturbed trench wall. Thrust blocks shall be sized and so placed to take all the thrust created by the directional change of water within the pipe.
 - 2. The concrete thrust block shall not encase the pipe or valves.
- J. Hydrostatic Testing: All mainline pipe with control valves in-place shall be pressure tested at a minimum of 100 PSI as measured at the water source for a three-hour period. Each valve shall be opened and closed during the test. Should the system not hold pressure, the leaks will be identified, repaired, and the system retested until it passes the above test.

3.6 VALVES

- A. Do not locate beneath paved surfaces.
- B. Install plumb to within 1/16-inch and within suitable box.
- C. Locate level within valve box with 6-inch deep layer of coarse gravel beneath bottom of valve. Valve boxes shall rest on non-deteriorating supports and of sufficient construction that tractors and mowers crossing over the boxes will not push boxes down and crush the pipe, valve, or box.
- D. All systems must provide an Isolation Valve between the water meter and backflow prevention device.

- E. Electric Control Valves:
 - 1. Position flow control handle in box to enable easy access for adjustment.
 - 2. Valves that may be grouped shall be in straight rows spaced a minimum of 18-inches apart and positioned 3-foot from any hardscape.
- F. Quick Coupler Valves: (if provided on Construction Drawings):
 - 1. Top of quick coupling shall be 3-inches below top of purple valve box and supported both vertically and horizontally.
 - 2. Isolation valve must be installed upstream of the quick coupling connection such that both units are accessible and operational.
 - 3. Threaded hose connections can only be used through a quick coupling key and labeled as “non-potable, not safe for drinking”.
- G. Master Valve (if provided on Construction Drawings):
 - 1. Locate on the discharge side of the backflow prevention device and/or pressure pump system.
 - 2. Valve shall be energized by master valve circuit on automatic controller.
- H. Cast Iron Isolation Valves (if provided on Construction Drawings):
 - 1. Installed with adjustable height valve boxes over each valve in the center of the square-nutted valve stem in the middle of the vertical riser of the valve box.

3.7 SPRINKLERS

- A. Emission devices must be installed to operate at the optimum and not the minimum/maximum sprinkler head pressure as published by the manufacturer for the nozzle and head spacing that is used. Methods to achieve the water pressure requirements include, but not limited to, flow control valves, pressure regulators, or pressure compensating spray heads.
- B. Install plumb to within 1/16-inch with top collar (not nozzle) flush to finish grade.
- C. Provide swing assembly or flex pvc to each spray device and rigid o-ring swing joint to each rotor device, except where entire spray nozzle is raised above grade and/or where rigid riser piping is shown per plan.
- D. Locate sprinkler between 4-inch and 6-inches from edge of paving or back of curb with flow directed away from adjacent impervious surface.
- E. Above ground emission devices may not be used in areas that are less than 48-inches (unless exceeded by local code) not including the impervious surfaces in either length or width and which contain impervious pedestrian or vehicular surfaces along two or more perimeters. Narrow walkways may be exempted from this requirement if the runoff drains into a landscape area.
- F. All nozzling shall be checked for proper discharge and arc of operation. Adjust arc and/or change nozzle if necessary to fit site conditions at no extra cost to the Owner. Prevailing wind conditions and area to be covered will determine correct arc of spray. All spray nozzles and rotors must have filter screens installed and free of debris.

3.8 DRIPPERLINE

- A. Install all dripperline as indicated on drawings. Use only Teflon tape on all threaded connections.
- B. Connect dripperline to barbed insert fittings by pushing the tubing on and over both barbs of the fitting until the tubing has seated against another piece of tubing or has butted against another portion of the barbed fitting. Clamp Techline fittings with Oetiker clamps when operating pressure exceeds specific dripperline fitting requirements.

- C. Install dripperline at row spacing intervals necessary for plant type, soil percolation, and sun exposure with one of the following methods:
1. Over-excavation: Over-excavate the entire area to a depth of 3" - 4" below finish grade. Plant all specimen trees and shrubs 15 gallon size and larger, then place dripperline.
 2. Pipe Pulling: Where ground disruption is to be minimized, pneumatic tire, pipe-pulling machinery shall be used. Potholes shall be used at the ends of each run for connection to supply and exhaust headers of rigid PVC pipe or polyethylene pipe.
 3. Trenching: Hand or mechanically trench to the pipe depth indicated and backfill flush with finish grade. Avoid mechanically trenching within the dripline of existing trees. Hand-trench around existing tree roots when roots of 2" and larger are encountered. Remove all rock 1½" and larger when excavating and remove from site. Do not backfill trenches with rock that will come in direct contact with tubing or rigid PVC piping.
 4. On-Grade Installation: For on-surface or under mulch installation, place tubing at the lateral spacing indicated and place soil staples on 3'-5' intervals depending on terrain. Do not install tubing on surface without sufficient soil staples. Backfill with 1"-2" of amended bed material and 3" of mulch or topdressing as indicated.
- D. When installing Techline CV or Techline dripperlines on-surface, install soil staples as listed below:
1. Sand Soil - One staple every three (3') feet and two (2) staples on each change of direction (tee, elbow, or cross).
 2. Loam Soil - One staple every four (4') feet and two (2) staples on each change of direction (tee, elbow, or cross).
 3. Clay Soil - One staple every five (5') feet and two (2) staples on each change of direction (tee, elbow, or cross).
- E. Cap or plug all openings as soon as lines have been installed to prevent the entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
- F. Prior to backfilling and before connection of the line flushing valves, flush the entire system to remove any dirt or sediment that may have entered the system during the installation.
- G. Install a pressure regulator below grade, in-line with, and downstream of the remote control valve. Whenever possible, place the pressure regulator in the same valve box to allow for periodic inspection. Place the regulator with the arrow (molded into the side of the body) pointing in the direction of the flow of water. Provide straight piping on the outlet side of regulator for a dimension not less than three lengths of the overall body dimension.
- H. Install the disc filter, horizontally level, below grade, and either before or after the remote control valve as indicated in the installation details. The position of the disc filter in the valve box shall be off-center to allow for removal of the disc element for periodic servicing. Include a minimum of 1 cubic foot of ¾" gravel in the bottom of the valve box.
- I. Install the air/vacuum relief valve at the highest elevation(s) within each zone of subsurface dripperline. Depending on the site conditions and tubing layout, more than one air/vacuum relief valve may be required. Place the valve in a round valve box with a locking cover and a sump of 1 cubic foot of ¾" gravel as noted on the details. Additional blank tubing may be necessary when placing dripperline on mounds or berms with more than a 3' elevation difference. Blank tubing shall be connected perpendicular to the dripperline with barbed tees and crosses from the lowest elevation of dripperline to the highest point of the mound berm where the air/vacuum relief valve is located. The air/vacuum relief lateral serves to collect and transport trapped air bubbles or relieve vacuum in lower elevation dripperline parallel to the dripperline located at the highest point in the system. Locate an air/vacuum relief lateral for each berm (high point) in the zone. Ensure the dripperline being used requires an air/vacuum relief valve. Some dripperlines with integral check valves built-in to each dripper do not require air/vacuum relief valves.

- J. Install the line flushing valve(s) below grade at the hydraulic termination point(s) in each system, normally at the point farthest away from the source. Locate in a valve box with the top of the line flushing valve facing horizontally or vertically. Include a minimum of 1 cubic foot of $\frac{3}{4}$ " gravel in the bottom of the valve box.

3.9 ELECTRICAL CONNECTIONS AND CONTROL WIRE

- A. Shall be in strict accordance with latest edition of National Electrical Code (NEC) and local electrical codes. Necessary permits and inspection tags shall be provided with Project Record Documents.
- B. Provide electrical connection to system as designated on Construction Drawings and as specified herein during dry weather conditions.
- C. Permanent controllers and any temporary controllers shall be wired to a separate circuit breaker serving only that controller or bank of controllers. If a surge protection device is not specified within the electrical plans, an Intermatic AG2401 surge protection device shall be installed on the supply wiring prior to branching out to each controller.
- D. Pressure pump systems as may be necessary for this project shall be installed with electrical components recommended by the manufacturer with dedicated electrical circuits to the pump device and controls.
- E. General:
 - 1. Do not run control and power supply wiring in same conduit.
 - 2. Wiring shall be inspected before and during installation to avoid nicks and broken insulation.
 - 3. Install and cap one extra signal and common wire to the last control valve in all directions from each controller. This wire serves as a spare conductor to be used in an emergency situation or for connection to a future valve.
 - 4. Provide continuous runs of wire between controller and valves when less than 500-feet. Splices shall be made with one of following:
 - a. Watertight below ground electrical junction boxes.
 - b. Water-tight connectors, such as utilized for valves, and located within valve box for ease of locating. Random field splices between the controller and valve will not be allowed.
 - 5. Bury control wire with separation below pipe in same trench. Bundle and tape together at not more than 25-foot intervals.
- F. Expansion Loops: Constructed by wrapping wire around 1/2-inch diameter pipe to create coil. A 3-foot section of wire shall be used to create 12-inch coil with 6-foot section being used to create 24-inch coil.
 - 1. Provide 12-inch coils at each wire splice, not including valves, and at each change of wire direction.
 - 2. Provide 24-inch coils at each control valve and where each valve enters conduit for automatic controller.

3.10 AUTOMATIC CONTROLLER

- A. Location and installation shall be as shown on Construction Drawings and approved by Owner prior to installation.
- B. Provide rigid conduits for both power supply and control wiring.
 - 1. Control wire conduit shall extend to 18-inches below grade.
 - 2. Secure conduit to wall with anchors and screws.
- C. Provide electrical grounding for controller in accordance with manufacturer's written instructions to obtain a maximum ground resistance of 10 ohms, or less.

- D. Landscape or turf grow in requirements may necessitate the need for temporary controllers. Such requirements shall be met with means as determined by the contractor in accordance with local water guidelines and restrictions.

3.11 BACKFILLING AND COMPACTION

- A. Sand or fine-grained soils should be used for initial backfill to sufficient depth to prevent damage to pipe from rocks or other debris during compaction of subsequent backfill.
- B. Fill trench to within 3-inches of finish grade with excavated soil and compact in accordance with Section 31 2316.
- C. Fill top 3-inches with existing topsoil in planting or turf areas and wheel roll until compaction of backfill is same as surrounding soil.
- D. Grade backfilled trench uniform with surrounding grades.
- E. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for compaction, then refilled and compacted with the surface restored to the required grade and left in a completed surface condition as described above.

3.12 VARIABLE SPEED PUMPING SYSTEM

3.13 COMPLETION OF SYSTEM INSTALLATION

- A. Upon completion of the work, clean and remove from the project all surplus and discarded materials, temporary equipment and debris. Leave the project site in a neat and orderly condition. Surplus and waste materials shall be legally disposed.
- B. Repair any damage to utilities, structures, or other improvements as a result of work related to the installation of the irrigation system, to its original condition at no cost to the Owner.
- C. Affix to each automatic controller a permanent sticker with waterproof ink which contains the irrigator's name, state issued license number, company name, telephone number, and the date of warranty period.
- D. After installation has been completed, make final adjustment of sprinkler system prior to Owner's Representative's final inspection.
 - 1. Completely flush system to remove debris from lines by removing nozzle from heads on ends of lines and turning on system.
 - 2. Check sprinklers for proper operation and proper alignment for direction of throw.
 - 3. Check each section for operating pressure and balance to other sections by use of flow adjustment on top of each valve.
 - 4. Check nozzling for proper coverage. Prevailing wind conditions may indicate that arc or angle of spray should be other than as shown on drawings. In this case, change nozzles to provide correct coverage and furnish record data to Owner's Representative with each change.
 - 5. After system is thoroughly flushed and ready for operation, each section of sprinklers shall be adjusted to control pressure at heads. Use the following method, one section at a time:
 - a. Remove last head on section and install a temporary riser above grade. Install tee with pressure gauge attached on top of riser and re install head with nipple onto tee.
 - b. Correct operating pressure at last head of each section as follows: Spray Heads 30 35 psi.
 - c. After replacing head, at grade, tamp thoroughly around head.
 - d. Drip zone valve pressure regulating devices shall be set at not to exceed 40 psi.
- E. Complete a Maintenance Checklist of the installed system which includes but is not limited to:

1. The manufacturer's manual for the automatic controller if not included with the controller.
 2. A seasonal (spring, summer, fall, winter) watering schedule based on the either current/real time evapo-transpiration or monthly historical reference evapo-transpiration (historical ET) data, monthly effective rainfall estimates, plant landscape coefficient factors, and site factors.
 3. A list of components, such as the nozzle, or pump filters, and other such components; that require maintenance and the recommended frequency for the service.
 4. The statement; "This irrigation system has been installed in accordance with all applicable state and local laws, ordinances, rules, regulations, or orders. I have tested the system and determined that it has been installed according to the Irrigation Plan and is properly adjusted for the most efficient application of water at this time."
- F. Complete PROJECT RECORD DOCUMENTS.
- G. Submit Maintenance Checklist and PROJECT RECORD DOCUMENTS to irrigation designer for Final Punchlist. Upon completion of the Final Punchlist by the irrigation designer, all Project Record Documents submitted will be returned to the Contractor or Prime Consultant.
- H. Contractor shall remediate all outstanding items and schedule a final "walk through" with the Owner or Owner's representative to deliver PROJECT RECORD DOCUMENTS to the Owner and explain the operation of the system in accordance with TCEQ Chapter 344.63.
- I. Upon acceptance, the Owner reserves the right to make repairs as necessary to keep the irrigation system in operating condition. The exercise of this right by the Owner shall not relieve the contractor of responsibilities under the terms of the guarantee.

END OF SECTION

SECTION 32 9000

PLANTING

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Preparation and excavation of planting beds.
- B. Planting of trees, shrubs, sod, seed, and associated materials.

1.2 RELATED SECTIONS

- A. Section 31 2300 – Excavation and Fill
- B. Section 31 2500 - Erosion and Sedimentation Control
- C. Section 32 8000 – Irrigation Systems
- D. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
 - 1. Z60.1 American Standard for Nursery Stock
- B. American Sod Producer Association (ASPA)
- C. American Nursery and Landscape Association (ANLA)

1.4 QUALITY ASSURANCE

- A. No error or discrepancy in Construction Drawings or Specifications shall cause defective or inappropriate materials to be used or poor workmanship to be allowed.
- B. Condition of new plant materials is responsibility of Contractor and shall be approved by Owner. Owner reserves right to inspect and reject plants at any time and place.
- C. Measure plants when branches are in their natural position.
- D. Trees and shrubs shall meet requirements for spread, height, or container size stated in Construction Drawings.
 - 1. Measurements are to be taken from ground level to average height of shrub and not to longest branch.
 - 2. Height and spread dimensions specified herein refer to main body of trees measured from crown of roots to tip of top branch.
- E. Caliper measurements shall be taken at point on tree trunk 6 inches above natural ground line for trees up to 4 inches in caliper, and at point 12 inches above natural ground line for trees exceeding 4 inches in caliper.
- F. If range of sizes is given, no plant shall be less than minimum size, and at least 50 percent of plants shall be as large as upper half of range specified.

- G. Measurements specified are minimum size acceptable and, where pruning is required, are measurements after pruning.

1.5 SUBMITTALS

- A. Before ordering or purchasing materials, provide samples of those materials to Owner for approval, if so requested.
- B. Submit certification tags from trees, shrubs, sod, and seed verifying type and purity.
- C. Unless otherwise authorized by Owner, notify Owner at least 48 hours in advance of anticipated delivery date of plant materials. Legible copy of invoice, showing kinds and sizes of materials included for each shipment, shall be furnished to Owner.
- D. Inform Owner of date when planting shall commence.

1.6 PROJECT CONDITIONS

- A. Work must be carried out only during weather conditions favorable to landscape construction and to health and welfare of plants. Owner shall determine suitability of such weather conditions.

PART 2 PRODUCTS

2.1 PLANT MATERIALS

- A. Plant material (trees and shrubs) shall conform to requirements of ANSI Z60.1 of rules and grading upgraded to meet the following:
 - 1. Plants shall be of selected specimen quality, exceptionally heavy, symmetrical, tightly knit, so trained or favored in their development and appearance as to be superior in form, number of branches, compactness and symmetry. Plants shall have normal habit or sound, healthy, vigorous plants with well developed root system.
 - 2. Plants shall be free of disease, insect pests, eggs, or larvae.
 - 3. Plants shall not be pruned before delivery.
 - 4. Trees with abrasion of bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 1 1/4-inch, which have not completely calloused, shall be rejected.
 - 5. Plants shall be typical of their species or variety and shall have normal habit of growth and be legibly tagged with proper name. Plants shall have been grown under climatic conditions similar to those of site or have been acclimated to such condition for at least 2 years.
 - 6. Root system of each plant shall be well-provided with fibrous roots. Parts shall be sound, healthy, vigorous, well-branched, and densely foliated when in leaf.
 - 7. Plants designated ball and burlap may be substituted with container grown.
 - 8. Plants installed as ball and burlap must be moved with root systems as solid units with balls of earth firmly wrapped with burlap and comply with the following:
 - a. Diameter and depth of balls of earth must be sufficient to encompass fibrous root feeding systems necessary for healthy development of plant.
 - b. No plant shall be accepted when ball of earth surrounding its roots has been badly cracked or broken preparatory to or during process of planting. Balls shall remain intact during all operations.
 - c. Plants that cannot be planted at once must be heeled-in by setting in ground and covering balls with soil or mulch and then watering.
 - d. Hemp burlap and twine is preferable to treated. If treated burlap is used, twine is to be cut from around trunk and burlap is to be removed.
 - 9. Trunk of each tree shall be single trunk growing from single unmutated crown of roots. No part of trunk shall be conspicuously crooked as compared with normal trees of same variety.
 - 10. Thickness of each shrub shall correspond to trade classification "No.1". Single-stemmed or thin plants shall not be accepted. Side branches must be generous,

well-twigged, and plant as whole well-branched to ground. Plants must be in moist condition, free from dead wood, bruises, or other root or branch injuries.

2.2 TOPSOIL

- A. Natural, friable, fertile, fine loamy soil possessing characteristics of representative topsoil in the vicinity that produces heavy growth.
- B. Topsoil, pH range of 5.5 to 7.4 with 3 to 4 percent organic material minimum, free from subsoil, objectionable weeds, litter, sods, stiff clay, stones larger than 1-inch in diameter, stumps, roots, trash, toxic substances, or any other material which may be harmful to plant growth or hinder planting operations.
- C. Verify amount stockpiled if any, and supply additional as needed from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain topsoil from bogs or marshes.

2.3 COMPOST

- A. Weed free and derived from a well-decomposed source of organic matter. The compost shall be produced using an aerobic composting process meeting CFR 503 regulations, including time and temperature data indicating effective weed seed, pathogen and insect larvae kill. The compost shall be free of any refuse, contaminants or other materials toxic to plant growth. Non-composted products will not be accepted. Test methods for the items below should follow USCC TMECC guidelines for laboratory procedures:
 - 1. PH – 5.0-8.0 in accordance with TMECC 04.11-A, "Electrometric pH Determinations for Compost"
 - 2. Non seeded compost blankets: Particle size – 100% passing a 2" sieve, 99% passing a 1" sieve, minimum of 90% passing a ¾" sieve in accordance with TMECC 02.02-B, "Sample Sieving for Aggregate Size Classification".
 - 3. For seeded Compost Blankets, seed should be incorporated at the time of application in the entire depth of the compost blanket, at rates per foot, per square yard, or per acre, as acceptable to the Architect/Engineer. The following particle sizes shall also be followed: 100% passing a 2" sieve, 99% passing a 1" sieve, minimum of 60% passing a ½" sieve. All other testing parameters remain the same. The seeding rates are generally similar or slightly higher than those used when considering application of seed via hydroseeding or other seeding methods.
 - 4. Moisture content of less than 60% in accordance with standardized test methods for moisture determination.
 - 5. Material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.

2.4 SHREDDED HARDWOOD BARK MULCH

- A. Mulch shall be of sufficient character as not to be easily displaced by wind or water runoff.
- B. Mulch shall be twice shredded and dark brown in color. All material shall be from a single production source and shall present a uniform appearance throughout the project.

2.5 FERTILIZER

- A. General: Fertilizer shall be a commercial product, uniform in composition, free flowing, and suitable for application with approved equipment. Fertilizer shall be delivered to the site in fully labeled original containers. Fertilizer which has been exposed to high humidity and moisture, has become caked or otherwise damaged making it unsuitable for use, will not be acceptable.
- B. Initial Planting Application: Fertilizer for the initial planting application shall be of N-P-K ratio of 4-5-1 (19-26-5). The phosphorous component must be derived from monoammonium phosphate to stimulate vigorous development of new roots, stolons, and rhizomes. This initial application must be applied and incorporated into the soil immediately prior to sodding.

1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.
 - C. Post Planting Application: Fertilizer for the post planting application will be a complete fertilizer of chemical base containing by weight the following percentages of nutrients: 27-3-4 +2% Fe (N-P-K) from methylene urea or the nitrogen equivalent of 33-3-10. The application rate should provide 1 lb. of N/1000 sq. ft.
 1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.
- 2.6 WATER
- A. Potable water, on-site water shall be furnished by Owner. Contractor shall furnish hose and other watering equipment.
- 2.7 LAWN SEED
- A. Seeding May 15 through September 15: Common Bermuda seed "Cynodon dactylon"; Hydromulch seed with hulled Common Bermuda at a rate of 4 lbs/1000 sf. Seeding shall be accomplished immediately after bed preparation. Hydroseed mixture shall contain cellulose mulch applied at a rate of 2000 lbs/acre, with a maximum of 50 lbs/100 gallons of water. If seeding is delayed after mixing 0.5 - 2 hours, add 50% seed mix. If delay is longer than 2 hours, begin with new mixture. Seed shall be at least 95% pure and shall have 90% minimum germination rate.
 - B. Seeding before April 15 or after September 15: Ryegrass Seed; Turfgrass seed shall be "Lolium multiflorum" (Italian or Annual Ryegrass). The seed shall be harvested within one (1) year prior to planting and shall be free of perennial ryegrass seed, other grass seed, and weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. Seed shall be at least 95% pure and shall have 90% minimum germination rate.
 - C. Certificate Submittal: Prior to planting, provide the Owner or his representative with the State Certificate stating analysis of purity and germination of seed.
 - D. "Hydro-Mulch" as manufactured by Conwed, or approved equal and composed of wood cellulose fiber with no germination or growth-inhibiting factors.
 - E. Hydro-Seeding Additive (Binder): Ecology 'Control-M-Binder' organic seeding additive or approved equal.
 - F. Seed Mixture: Provide seed of grass species and varieties, proportions by weight and minimum percentages of purity, germination, and maximum percentage of weed seed. Seed mixtures vary by region and season and shall comply with State DOT and Local Soil Conservation Service standards.
- 2.8 SOD
- A. Common Bermuda Sod: Turfgrass sod shall be 100% "Cynodon dactylon" (Common Bermuda grass). Sod shall consist of stolons, leaf blades, rhizomes and roots with a healthy, virile system of dense, thickly matted roots throughout the soil of the sod for a thickness not less than three-quarters (3/4") inch. Sod shall be alive, healthy, vigorous, free of insects, disease, stones, and undesirable foreign materials and grasses. The grass shall have been mowed prior to sod cutting so that the height of grass shall not exceed two (2") inches. Sod shall have been produced on growing beds of clay-loam topsoil. Sod shall not be harvested or planted when its moisture condition is so excessively wet or dry that its survival will be affected. All sod is to be harvested, delivered, and planted within a thirty-six (36) hour period of time. Sod shall be protected from exposure to wind, sun, and freezing. If sod is stacked, it shall be kept moist and shall be stacked roots-to-roots and grass-to-grass.
- 2.9 TREE STAKING MATERIAL

- A. Above ground staking system:
 - 1. Stakes shall be 6-ft steel tee posts. Three stakes shall be used for each tree.
 - 2. Wire used for tree staking shall be pliable No. 12 galvanized soft steel wire.
 - 3. Hose shall be 2-ply fibred-bearing rubber garden hose, not less than 1/2-inch inside diameter, black or green, and of suitable length.
- B. Below ground staking system:
 - 1. Untreated lumber (2" x 2")
 - 2. Arborite 3/4" woven polypropylene strap (when necessary) Color: olive

2.10 WEED PREVENTIVE BARRIER

- A. Woven polypropylene, 4.1 ounce, needle punched fabric or equal weed barrier.

2.11 STEEL EDGING

- A. Steel edging to be manufactured 4" by 16-foot sections with interlocking system without offset or double thickness at the splice/joint.
- B. Each stake location shall be fabricated into the section with two stakes at every joint.
- C. Steel stakes are to be a minimum of 12-inch long for 1/8" edging and 15-inches long for 3/16" and 1/4" edging.
- D. Edging thickness shall 3/16" unless otherwise indicated by landscape plan or detail.
- E. Edging to be powder coated, baked on enamel and specified on plan as green, black, or brown.

2.12 DECOMPOSED GRANITE

- A. Principal material shall consist of a natural mix of granite aggregate not to exceed 1/4" diameter in size and various stages of decomposed earth base.
- B. Filter fabric shall be "Mirascape", non-woven needle punched fabric made from polypropylene, non-biodegradable, inert to soil chemicals, acids and alkalines over a pH range of 3-12, as manufactured by MIRAFL Inc., or approved equal.
- C. Binder additive thoroughly mixed throughout at 12-16 lbs of stabilizer per ton of decomposed granite as provided by Stabilizer Solutions; www.stabilizersolutions.com or equal.

PART 3 EXECUTION

3.1 PROTECTION

- A. Before commencing work, trees and shrubs that are to be saved shall be protected from damage by placement of fencing flagged for visibility or some other suitable protective procedure approved by Owner. No work may begin until this requirement is fulfilled.
- B. In order to avoid damage to roots, bark, or lower branches, no truck or other equipment shall be driven or parked within drip line of any tree, unless tree overspreads paved area.
- C. Use precautionary measures when performing work around trees, sidewalks, pavements, utilities, and other features either existing or previously installed.
- D. Adjust depth of earthwork and topsoil when working immediately adjacent to aforementioned features in order to prevent disturbing tree roots, undermining sidewalks and pavements, and damage in general to other features either existing or previously installed.
- E. Cover plants transported to project in open vehicles with tarpaulins or other suitable covers securely fastened to body of vehicle to prevent injury to plants. Closed vehicles shall be adequately ventilated to prevent overheating of plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. Plants shall be kept moist, fresh, and protected. Such protection shall encompass entire period during which plants are in transit, being handled, or are in temporary storage.

- F. Where excavating, fill, or grading is required within drip line of trees that are to remain, work shall be performed as follows:
1. Trenching: When trenching occurs around trees to remain, tree roots shall not be cut but trench shall be tunneled under or around roots by careful hand digging without injury to roots.
 2. Raising Grades:
 - a. Where fill not exceeding 16 inches is required, clean, washed gravel graded from 1 inch to 2 inches in size shall be placed directly around tree trunk. Extend gravel out from trunk on all sides minimum of 18 inches and finish approximately 2 inches above finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with trunks of trees requiring fill.
 - b. Where fill exceeding 16 inches is required, construct dry-laid tree well around trunk of tree. Tree well shall extend out from trunk on all sides minimum of 3 feet and to 3-inches above finish grade. Place coarse-graded rock directly around tree well extending out to drip line of tree. Place clean, washed gravel graded from 1 inch to 2 inches in size directly over coarse rock to depth of 3 inches. Place approved backfill material directly over washed gravel to desired finish grade.
 3. Lowering Grades: Existing trees in areas where new finish grade is to be lowered shall have regrading work done by hand to elevation indicated on Construction Drawings. Roots as required shall be cut cleanly 3 inches below finished grade and scars covered with tree paint.
 4. Trees marked for preservation that are more than 6 inches above proposed grades shall stand on broad rounded mounds and graded smoothly into lower level. Trees located more than 16 inches above proposed grades shall have dry-laid stone wall or other retaining structure as detailed on Construction Drawings constructed minimum of 5 feet from trunk. Exposed or broken roots shall be cut clean and covered with topsoil.

3.2 PREPARATION

- A. If project completion date prohibits in-season planting, prepare for out-of-season seeding or sodding so that lawns shall be completed and ready for acceptance at time of project completion, without additional cost to Owner.
- B. Provide sufficient tools and equipment required to carry out planting operation.
- C. Locations containing unsuitable subsoil shall be treated by one or more of the following:
1. Where unsuitability is deemed by Owner to be due to excessive compaction caused by heavy equipment and where natural subsoil is other than AASHTO classification of A6 or 7, loosen such areas with spikes, discing, or other means to loosen soil to condition acceptable to Owner. Loosen soil to minimum depth of 12 inches with additional loosening as required to obtain adequate drainage. Contractor may introduce peat moss, sand, or organic matter into the subsoil to obtain adequate percolation. Such remedial measures shall be considered as incidental, without additional cost to Owner.
 2. Where unsuitability is deemed by Owner to be due to presence of boards, mortar, concrete, or other construction materials in sub-grade and where natural subsoil is other than AASHTO classification of A6 or 7, remove debris and objectionable material. Such remedial measures shall be considered as incidental, without additional cost to Owner.
 3. Where unsuitability is deemed by Owner to be because natural subsoil falls into AASHTO classification of A6 or 7 and contains moisture in excess of 30 percent, then installation of sub-drainage system or other means described elsewhere in Specifications shall be used. Where such conditions have not been known or revealed prior to planting time and they have not been recognized in preparation of Construction Drawings and Specifications, then Owner shall issue pricing order to install proper remedial measures.
- D. Perform planting operations at steady rate of work unless weather conditions make it impossible to work. No plant material shall be planted in frozen ground.

- E. Disk, drag, harrow, or hand rake subgrade to depth of 4 inches and removed stones larger than 1-1/2 inches to provide bond for topsoil. Topsoil, which must be transported across finished sidewalks, shall be delivered in such manner that no damage will be done to sidewalks. Contractor shall be responsible for repair of such damage.
- F. Do not place topsoil until subgrade has been approved in accordance with Section 31 2300. Before placing topsoil, rake subsoil surface clear of stones, debris, and roots. Compact topsoil to form layer with minimum depth of 4-inches in lawn areas and 12-inches in shrub beds. Place topsoil so that after final settlement there will be positive drainage conforming to elevations shown on Construction Drawings.
- G. Tree and Shrub Preparation
 - 1. Dig bare-rooted shrubs with adequate fibrous roots. Cover roots of these plants with uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw or moss.
 - 2. Dig ball and burlap plants with firm natural balls of earth of diameter and depth to include fibrous roots.
 - 3. Protect roots or balls of plants at all times from sun and drying winds.
 - 4. Ball and burlap plants which cannot be planted immediately upon delivery shall be set on ground and protected with soil, wet moss, or other acceptable material. Heel-in bare rooted plants that cannot be planted immediately upon delivery. All shall be kept moist.
 - 5. Open and separate bundles of plants before roots are covered. Take care to prevent air pockets among roots. During planting operations, cover bare roots with canvas, hay, or other suitable material. No plant shall be bound with wire or rope at any time so as to damage bark or break branches.
- H. Seed Bed Preparation
 - 1. Grade areas to finish grades, filling as needed or removing surplus dirt. Float areas to smooth, uniform grade as indicated on Construction Drawings. Lawn areas shall slope to drain.
 - 2. Where no grades are shown, areas shall have smooth and continual grade between existing or fixed controls, such as walks, curbs, catch basin, steps, or building, and elevations shown on Construction Drawings. Roll, scarify, rake, and level as necessary to obtain true, even lawn surfaces. Finish grades shall meet approval of Owner, Landscape Architect, or Engineer before grass seed is sown.
 - 3. Loosen soil to depth of 6 inches in lawn areas by approved method of scarification and grade to remove ridges and depressions. Remove stones or foreign matter over 2 inches in diameter from top 2 inches of soil. Float lawn areas to finish grades.
 - 4. Seed beds should be permitted to settle or should be firmed by rolling before seeding begins.
- I. Sod Bed Preparation: Grade areas to finish grade, filling as needed or removing surplus dirt, stones, debris, etc. and floating areas to smooth, uniform grade as indicated on Construction Drawings. Lawn areas are to be graded to drain.

3.3 TREE AND SHRUB PLANTING

- A. Planting shall not proceed until all irrigation spray/rotor heads have been installed or flagged. The location of any head shall govern over the location of plant material. Plant material shall be located to allow the unobstructed performance of irrigation heads.
- B. Plants too large for 2 persons to lift in and out of holes shall be placed with sling. Do not rock trees in holes to raise.
- C. If rock or other underground obstruction is encountered, Owner may require plant pits to be relocated, pits enlarged, or plants deleted from project.
- D. Make adjustments in locations as directed. In event that pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations,

they shall be so marked that when planting proceeds, they can be readily located. In case underground obstructions such as ledges or utilities are encountered, change location under direction of Owner without charge.

- E. Holes for trees shall be at least 2 feet greater in diameter than spread of root system and at least 6 inches deeper than root ball. Holes for shrubs and vines shall be at least 12 inches greater in diameter than spread of root system and at least 2 feet deep.
- F. During backfilling of tree holes and shrub beds with topsoil, manure, ground limestone (if soil tests indicate it is needed), and commercial fertilizer at rate of 3 pounds for trees up to 3 inches in caliper, 1 pound per inch caliper for larger trees, 6 ounces for small shrubs and 8 ounces for each shrub 4 feet or over shall be added as progress of work permits. Omit ground limestone and manure in case of acid soil plants. Manure, limestone, and fertilizer shall be thoroughly mixed with topsoil in planting operation, care being taken that manure does not come in immediate contact with roots.
- G. Trees shall be planted in center of holes with the root ball placed minimum 1 inch above grade and maximum of 1 ½ inches above grade.
- H. Plants shall be planted in center of holes and at same depth as they had previously grown. Backfill topsoil in layers of not more than 8 inches and each layer watered sufficiently to settle before next layer is placed. Tamp loam under edges of balled plants. Use enough topsoil to bring surfaces to finish grade when settled.
 - 1. Provide saucer around each plant as shown on Construction Drawings.
 - 2. Soak plants with water twice within first 24 hours after time of planting. Apply water with low pressure so as to soak in thoroughly without dislodging topsoil.

3.4 SEEDING

A. PREPARATION

- 1. If weeds exist within proposed seeding areas at the beginning of work, spray with a nonselective systemic contact herbicide, as recommended and applied by an approved licensed applicator.
- 2. Clear and remove these existing weeds upon herbicide's completed action by grubbing off all plant parts at least 1" below the surface of the soil.
- 3. If Bermuda grass exists in areas planned for Bermuda grass, Contractor shall retain the existing grass.

B. HYDROMULCH APPLICATION

- 1. For all seeded areas, install sod strip of Bermuda grass as stated on the design plan sheet.
- 2. Lawn areas to be seeded immediately after preparation of the bed. Apply a uniform coat of hydromulch at the rates indicated.
- 3. Immediately following application of hydromulch, the Contractor shall wash excess material from previously planted material, architectural features, fencing, paving, etc. with protection to such site amenities and irrigation system components. Care shall be exercised to avoid washing or eroding mulch materials from lawn areas.
- 4. Upon establishment of lawn, apply a post emergent herbicide for control of Nutgrass and weeds. Fertilize monthly with 1 pound of N/1000 square feet.
- 5. Should lawn area be seeded with Annual Rye Grass due to seasonal conditions, Contractor shall return to the site between April 15 and May 15 to re-prepare seed bed and hydromulch with common Bermuda seed in order to establish a permanent turf cover in all lawn areas.

3.5 SOD

A. SOLID SOD

1. A 3' wide strip shall be sodded along sidewalks, roadways, parking areas, and drainage structures to prevent washing and erosion. Top of sod shall be 1" below paved surface.
2. Laying sod: Prior to laying the sod, the planting bed shall be raked smooth to true grade and moistened to a depth of four (4") inches, but not to the extent causing puddling. The sod shall be laid smoothly, tightly butted edge to edge, and with staggered joints.
3. Rolling: The sod shall be pressed firmly into contact with the sod bed by rolling so as to eliminate all air pockets, provide a true and even surface, and insure knitting without displacement of the sod or deformation of the surfaces of sodded areas.
4. Smoothing: Following compaction, fine screened soil of good quality shall be used to fill all cracks between sod sections. Excess soil shall be worked into the grass with suitable equipment and shall be well watered. The quantity of fill soil shall be such that it will cause no smothering of the grass.

B. PROTECTION

No heavy equipment shall be moved over the planted turf area unless the soil is again prepared, graded, leveled, and replanted. It will be the responsibility of the Contractor to protect all paving surfaces, curbs, utilities, plant materials, and any other existing improvements from damage. Any damages shall be repaired or replaced at no cost to the Owner. The Contractor will also locate and stake all irrigation heads, valve risers, etc., prior to beginning any soil preparation work.

C. FERTILIZING

1. Initial Planting Application: The fertilizer shall be applied at the rate of nine (9) pounds per one thousand (1000) square feet (400 pounds per acre).
 - a. Timing: The initial planting application of fertilizer shall be applied over sodded areas after planting, but not more than two (2) days later.
2. Post Planting Application: Thirty (30) days after planting, turfgrass areas shall receive the specified post planting fertilizer at the rate of one (1) pound of nitrogen per one thousand (1000) square feet (45 pounds per acre).
 - b. Timing: The Owner or his representative will determine if it is too late in the growing season for the post planting application. In the event that it is, the application shall be made in the spring of next year, or the cost of the application may become a credit due to the Owner.
3. Post Planting Maintenance: Areas without a uniform stand (complete coverage) that must be maintained later than thirty (30) days after the initial planting shall receive subsequent applications of fertilizer, as described above, every thirty (30) days until a uniform stand is achieved.

3.6 DECOMPOSED GRANITE

Site Preparation

1. Areas to receive decomposed granite shall be cleared of trash and debris. Weeds shall be removed to the ground.
2. After clearing, areas to receive decomposed granite shall be excavated to the depth shown on the plans. Where decomposed granite is to be placed adjacent to curbs or edging, the subgrade shall be excavated such that the finished elevation of the decomposed granite is flush with the top of the curb or edging.

3. Prior to placement of decomposed granite, the subgrade surface shall be smooth, firm, stable and free of rocks, clods, foliage, roots or other material greater than 1" in diameter.
- B. Placement
1. Weed control fabric shall be placed in areas to receive decomposed granite as recommended by the manufacturer and as specified herein. Weed control mat shall be placed loosely with longitudinal and transverse joints overlapped 4" and stapled to the subgrade at 6" on center. Staples shall be driven perpendicular to the ground surface. Following placement, the fabric shall lay flat, smooth and be in uniform contact with the soil surface, without bulges or wrinkles.
 2. Each layer of decomposed granite shall be raked to evenly blend various materials and form a smooth uniform surface.
 3. Decomposed granite shall be moistened sufficiently to obtain the required compaction. Each layer of decomposed granite shall be brought to a relative compaction of not less than 90 percent by compaction equipment such as a double drum roller, single drum roller, vibratory tamp or small plate compactor. After placement of decomposed granite, compaction shall not begin less than 6 hours after placement, nor later than 48 hours.
 4. When work is complete, the surface shall be smooth and uniform; maintaining original flow lines, slope gradient and contours of the project site. If cracks develop in the surface of the decomposed granite, loose fines shall be swept into the cracks, watered thoroughly and hand tamped.

3.7 MISCELLANEOUS INSTALLATIONS

- A. Use compost for planting soil mixture only and not be used as mulch, except on specified ground covers.
- B. Areas to be covered with erosion control blankets shall be properly prepared, fertilized, and seeded before blanket is applied. When blanket is unrolled, netting shall be on top and fibers in contact with soil. In ditches, apply blanket in direction of flow of water. On slopes, apply blankets vertically on slope. Butt ends and sides snugly and staple to manufacturer's recommendations.
- C. Shredded Hardwood Bark Mulch
1. Use 4 inches of shredded hardwood bark mulch or approved equal as top dressing in planting beds. Mulch single trees or shrubs to outside edge of saucer.
 2. Place weed mat under planting areas not to be seeded, or as directed on Construction Drawings. Cover mat with mulch and secured in place with soil anchor.
- D. Steel edging shall be installed only where a hard surface does not exist to define a planting bed from adjoining turf and follow the alignment shown in the construction documents. Install edging with stake pockets on inside of bed. Backfill both sides to maintain form with the top of edging not exceeding finish turf grade by more than 1.5-inches. Steel edge shall maintain a consistent vertical position and terminate flush with hard surfaces with no sharp corners exposed. Corners shall be formed by cutting from the bottom approximately 1" to bend to the desired angle.
- E. Apply fertilizer to grass or sodded areas in 2 applications with thorough watering immediately following. First application shall be 1 week before seeding at rate of 35 pounds per 1,000 square feet harrowed into top 2 inches of seedbed. Second application shall be done at rate of 25 pounds per 1,000 square feet, immediately following second mowing.

3.8 MAINTENANCE DURING CONSTRUCTION

- A. Begin maintenance immediately after planting. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected until acceptance. Settled plants shall be reset to proper grade and position, planting saucer restored, and dead material removed and replaced. Tighten and repair stakes and wires.

Correct defective work as soon as possible after it becomes apparent and weather and season permit.

- B. Maintain lawns for at least 30 days after sodding and 60 days after seeding, or as long as is necessary to establish uniform stand of the specified grasses, or until substantial completion of project, or until acceptance of lawns, whichever is later.
- C. In event that lawn operations are completed too late in Fall for adequate germination and/or growth, maintenance shall continue into following growing season or until uniform stand of specified grasses has been established.
- D. Make weekly inspections to determine moisture content of soil and adjust watering schedule established by irrigation system installer to fit conditions.
- E. After grass growth has started, areas that fail to show uniform stand of grass for any reason whatsoever shall be reseeded in accordance with Construction Drawings and as specified herein. Such areas shall be reseeded repeatedly until areas are covered with satisfactory growth of grass at no additional cost to Owner. Topsoil conditioning or removal and replacement shall be performed if required to facilitate establishment of grass at no cost to Owner.
- F. Watering shall be done in such manner and as frequently as is deemed necessary by Owner to assure continued growth of healthy grass. Water areas of site in such a manner as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to finished surface due to watering equipment.
- G. Water for execution and maintenance will be provided by Contractor at no expense to Owner. Contractor shall furnish portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport water from available outlets and apply it to seeded areas in approved manner.
- H. Initiate mowing of seeded areas when grass has attained height of 3 inches. Maintain grass height at 2 1/2 to 3 inches at subsequent cuttings depending on time of year. Not more than 1/3 of grass leaf shall be removed at any cutting and cutting shall not occur less than 10 days apart.
- I. Heavy cuttings shall be removed to prevent destruction of underlying turf. If weeds or other undesirable vegetation threaten to smother planted species, such vegetation shall be mowed or, in case of rank growths, shall be uprooted, raked and removed from area by methods approved by Owner.
- J. Protect seeded area from pedestrian or vehicular trespassing while grass is germinating. Furnish and install fences, signs, barriers, or other necessary temporary protective devices. Contractor shall repair damage resulting from trespass, erosion, washout, settlement, or other causes at his expense.
- K. Remove fences, signs, barriers, or other temporary protective devices after final acceptance.
- L. If substantial number of plants are diseased, distressed, or dead at time of inspection, acceptance will not be granted and Contractor's responsibility for maintenance of plants shall be extended until replacements are made.
- M. Replacements shall be plants of same variety and size specified on Construction Drawings. Furnish and plant as specified herein. Cost shall be borne by Contractor. Replacements resulting from removal, loss, or damage due to occupancy of project in any part, vandalism, physical damage by animals, vehicles, etc., and losses due to curtailment of water by local authorities will be approved and paid for by Owner.
- N. Remove and replace dead, defective and/or rejected plants as required before final acceptance. Replacement of plant materials that may be necessary shall be at expense of Contractor.

- O. Grassed areas damaged during process of work shall be responsibility of Contractor, who shall restore disturbed areas to condition satisfactory to Owner. This may include filling to grade, fertilizing, seeding, and mulching.
- P. Guarantee plants for period of 2 years after inspection and acceptance.
- Q. At end of Establishment Period, inspection shall be made again. Remove from site any plant that is dead or unsatisfactory to Owner. Replace plants during normal planting season.

END OF SECTION

SECTION 33 3100

SANITARY SEWAGE SYSTEMS

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
- B. Connection of site sanitary sewer system to municipal sanitary sewer systems.

1.2 RELATED REQUIREMENTS

- A. Section 32 2316 – Trenching and Backfill
- B. Section 33 3913 - Sewer Manholes, Frames, and Covers
- C. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
 - 1. A74 Cast Iron Soil Pipe and Fittings
 - 2. A746 Ductile Iron Gravity Sewer Pipe
 - 3. C12 Practice for Installing Vitrified Clay Pipe Lines
 - 4. C150 Portland Cement
 - 5. C207 Hydrated Lime for Masonry Purposes
 - 6. C425 Compression Joints for Vitrified Clay Pipe and Fittings
 - 7. C478 Precast Reinforced Concrete Manhole Sections
 - 8. C564 Rubber Gaskets for Cast Iron Soil Pipe and Fittings
 - 9. C700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
 - 10. C828 Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines
 - 11. D1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 - 12. D2141 Poly (vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
 - 13. D2657 Heat-Joining Polyolefin pipe and Fittings
 - 14. D3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 - 15. D3035 Polyethylene (PE) Plastic Pipe Using Flexible Elastomeric Seals
 - 16. D3139 Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals
 - 17. D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
 - 18. D3261 Butt heat fusion Polyethylene (PE) Plastic Fittings for Polyethylene Plastic pipe and Tubing
 - 19. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
 - 20. F1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
- B. American Water Works Association (AWWA) latest edition
 - 1. C111 Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
 - 2. C600 Ductile-Iron Water mains and Their Appurtenances
 - 3. C900 Polyvinyl Chloride (PVC) Pressure pipe, 4 in. Through 12 in, for Water Distribution
 - 4. C901 Polyethylene (PE) Pressure pipe, Tubing and Fittings 1/2 inch through 3 inches, for Water Distribution
 - 5. C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch, for Water Distribution

1.4 QUALITY ASSURANCE

- A. An independent testing laboratory will be retained to perform construction testing on site.

1.5 SUBMITTALS

- A. Product Data: Provide data of pipe materials, pipe fittings, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified or local requirements.

1.6 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of pipe runs, connections, cleanouts, and invert elevations. Score mark and paint on top of curb or edge of pavement over all buried utility lines.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.7 PROJECT CONDITIONS

- A. Coordinate work with termination of sanitary sewer connection outside building and connection to municipal sewer utility service.

PART 2 PRODUCTS

2.1 SEWER PIPE, FITTINGS, AND JOINTS
(Exterior to Building except as noted)

- A. Polyvinyl Chloride Pipe (PVC): ASTM D 3034, rated SDR 35 unless otherwise specified by the utility company. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification.
1. Pipe joints: Integrally molded bell ends, ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.
 2. Trace Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with "Sanitary Sewer Service" in large letters.
- B. Vitrified Clay Pipe (VCP): ASTM C700: (Use only if required by local jurisdiction)
1. Fittings: ASTM C700
 2. Joints: ASTM C425
 3. Gaskets: ASTM C425. Gaskets shall be manufactured from high grade, properly vulcanized elastomeric compound consisting of either basic natural or synthetic rubber. Gasket manufacturing tolerances shall comply with Rubber Manufacturer's Association tolerances for gaskets.
 4. Lubricant: Suitable for lubricating joint components; no deteriorating effects on gasket or pipe material, will not support growth of fungi or bacteria, and shall be of type recommended by gasket manufacturer.
 5. Trace Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with "Sanitary Sewer Service" in large letters.
- C. Ductile Iron Pipe (DIP): ASTM A746, Class 50, inside nominal diameter as specified on Construction Drawings, bell and spigot end.
1. Ductile Iron Pipe Joint Device: AWWA C111, rubber gasket joint devices.
- D. Cast Iron Pipe (CISP)(Building Interior ONLY): ASTM A74, Service grade (SV), inside nominal diameter as specified on Construction Drawings, bell and spigot end.

1. Cast Iron Pipe Joint Device: ASTM C564, rubber gasket joint devices.
 - E. Force Main:
 1. High-Density Polyethylene Pipe (HDPE): AWWA C901 and C906, ASTM D3035, SDR 11 for 150psi pressure rating.
 - a. Fittings: Molded, AWWA C901 or C906.
 - b. Joints: Butt fusion, ASTM D2657, flanged gasket joints at interface
 - c. Trace Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with "Sanitary Sewer Service" in large letters.
 2. Polyvinyl Chloride Pipe (PVC): For less than 4 inches in diameter, ASTM D2241 for push-on or solvent weld joints, and for pipe 4 inches in diameter and larger, AWWA C900, Class 150 with push-on joints.
 - a. Joints/Fittings: Push-on, ASTM D3139 with ASTM F477 gaskets.
 - b. Solvent Cement: ASTM D2564
 - 2.2 PIPE ACCESSORIES
 - A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene-ribbed gasket for positive seal.
 - B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, etc.
 - 2.3 CLEANOUTS AND MANHOLES
 - A. Precast concrete manholes section shall conform to Section 33 3913.
 - B. Lid and Frame: Provide traffic grade and rated covers and frames where cleanouts and manholes are within pavement, with the letters "SSCO" or "SANITARY SEWER" respectively cast into the cover, unless municipality requires other notation.
 - C. Shaft Construction: Cast Iron shaft of internal diameter as specified on Construction Drawings with 3000 psi concrete collar for cleanouts.
- PART 3 EXECUTION
- 3.1 EXAMINATION
 - A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.
 - 3.2 PREPARATION
 - A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
 - B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.
 - 3.3 BEDDING
 - A. Excavate trench and place bedding material in accordance with Section 31 2316.
 - 3.4 INSTALLATION - PIPE
 - A. The type and class of pipe used shall be as shown on the construction plans. Pipes shall be laid and maintained to the required line and grade with necessary fittings, bends, manhole risers, cleanouts and other appurtenances placed at the required locations. The pipe shall be installed with uniform bearing under the full length of the barrel of the pipe. The pipe shall

be inspected for defects and cracks before carefully being lowered into the trench. Any defective, damaged or unsound pipe, or any pipe that has had its grade disturbed after laying shall be taken up and replaced. Commence installation at lowest point with the bell end upgrades.

- B. No pipe shall be laid in water or when trench conditions are unsuitable for work.
- C. Pipe connecting to manholes or other structures shall terminate flush inside of the structure wall.
- D. Joints for PVC and CISP shall be thoroughly lubricated with an approved lubricant before pipe sections are slipped together. Open ends shall be fully protected with a stopper to prevent earth or other material from entering the pipe during construction. Carefully free interior of the pipe from dirt, cement and other deleterious material as the work progresses.
- E. Maintain separation of potable water main for sewer piping (10 foot horizontal and 18 inches vertical at crossings, minimum).
- F. Install HDPE piping and fittings to AWWA C901 and C906. Butt fusion welded per ASTM D3261.
- G. Route pipe in straight line parallel to roads, buildings and adjacent utilities and as shown on construction drawings.
- H. Establish elevations of buried piping with sufficient cover as recommended by pipe manufacturer to ensure not less than 3-feet of cover, except as noted on drawings.
- I. Form and place concrete for thrust blocks at each elbow of pipe force main. See construction drawing for details of construction.
- J. Backfill trench in accordance with Section 31 2316.
- K. Install trace wire continuous over top of non-metal pipe. Bury 18 inches minimum below finish grade, above pipeline.

3.5 INSTALLATION – CLEANOUTS AND MANHOLES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. For cleanouts, form and place cast-in-place concrete base pad with provision for sanitary sewer pipe to be installed to proper elevations.
- C. For manholes, construct inverts according to the following guidelines:
 - 1. Invert channel shall be smooth and accurately shaped to a semicircular bottom to match with the inside of the adjacent sewer section.
 - 2. Invert channels and structure bottoms shall be shaped with mortar and lean concrete.
 - 3. Changes in size and grade of invert shall be made gradually and evenly.
 - 4. Changes in the direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
- D. For manholes, provide manhole rings, frame, and cover as shown on the construction drawings.

3.6 FIELD QUALITY CONTROL

- A. Pipes and joints shall not be completely backfilled until after inspection, testing, and approval by the Owner and local jurisdiction.

- B. Prior to testing for leakage, the pipe trench shall be backfilled to at least the spring line of the pipe. If required to prevent pipe movement during testing, additional backfill shall be added leaving the pipe joints uncovered to permit inspection.
- C. Exfiltration Test
 - 1. Each section of sewer line between successive manholes shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole, using stoppers.
 - 2. Fill the manhole and pipe with water to a point which produces a maximum of 3-feet of head above the invert of the sewer at the center of the upper manhole; or if groundwater is present, 3 feet of head above the average adjacent groundwater level.
 - 3. The allowable leakage shall be:
 - a. 200 gal/inch of pipe diameter/mile/day
- D. Infiltration Test
 - 1. If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test shall not be used.
 - 2. The upper and lower ends of the sewer to be tested shall be closed sufficiently to prevent the entrance of water.
 - 3. Pumping of ground water shall be discontinued for at least 3 days; then infiltration shall be tested.
 - 4. Infiltration into each section of sewer between adjoining manholes shall not exceed that allowed for the exfiltration test, except that head conditions shall be a maximum of 6-feet.
- E. Provide measuring devices, meters, water, materials, and labor for making the required tests.
- F. Gravity systems shall be air tested between manholes at 3.5 psi for 5 minutes per ASTM F 1417 for plastic pipes. The Exfiltration Test may be limited to the manholes only when the authority having jurisdiction does not require the test and the construction manager waives the test. The Infiltration Test will always be required when excessive ground water is encountered in addition to the air test.
- G. Tests shall be conducted in the presence of the Engineer or his designee. Test data shall be submitted to the Engineer for review and approval.
- H. All force main piping shall be hydrostatically tested at 150 psi in accordance with AWWA C 600.
- I. If deflection test is to be run using a rigid ball or mandrel. It shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.
- J. Allowable Deflection: Maximum allowable pipe deflection shall not exceed 5 percent of nominal inside diameter.
 - 1. Mandrel: Mandrel, go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of sewer to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01-inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test.
 - 2. Procedure: Mandrel shall be hand-pulled through flexible pipe sewer lines no earlier than 30 days after trench has been completely backfilled. Sections of sewer

not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to satisfaction of Owner or governing agency. Repaired section shall be retested.

END OF SECTION

SECTION 33 3913

SEWER MANHOLES, FRAMES, AND COVERS

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Monolithic concrete manhole barrel with either monolithic concrete or masonry transition to lid frame.
- B. Modular precast concrete manhole barrel with tongue-and-groove joints with either precast concrete or masonry transition to lid frame.
- C. Masonry manhole barrel with masonry transition to lid frame.
- D. Precast polyethylene manhole assemblies.
- E. Preparation and installation of lid frame, covers, anchorage, and accessories.

1.2 RELATED SECTIONS

- A. Section 31 2316 – Trenching and Backfill
- B. Section 33 3100- Sanitary Sewer Systems
- C. Section 33 4000 - Storm Drainage
- D. Section 03 3000 – Cast In Place Concrete (see Architectural/Building Specifications)
- E. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
 - 1. A 48 Gray Iron Castings
 - 2. C 55 Concrete Building Brick
 - 3. C 478 Precast Reinforced Concrete Manhole Sections
 - 4. C 923 Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
 - 5. D 1248 Polyethylene Plastics Molding and Extrusion Materials
- B. International Masonry Industry All-Weather Council (IMIAC) latest edition
 - 1. Recommended Practices and Guide Specification for Cold Weather Masonry Construction
- C. State Department of Transportation (DOT), Construction and Material Specifications, Latest Edition

1.4 SUBMITTALS

- A. Shop Drawings: Indicate reference to Construction Drawings of manhole locations, elevations, piping with sizes, locations, and elevations of penetrations.
- B. Product Data: Provide data for manhole covers, component construction, features, configuration, and dimensions.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Manhole Barrel: Nonreinforced cast in place concrete in accordance with Section 03 3000.
- B. Cast-In-Place Manholes: 4000 psi concrete @ 28 days.
- C. Forms: Steel sheet accurately shaped and fabricated of sufficient strength to form dense watertight walls to true dimensions.
- D. Manhole Barrel: Reinforced precast concrete in accordance with ASTM C 478 with gaskets in accordance with ASTM C 923.
 - 1. Construct manholes of precast concrete sections as required by Construction Drawings to size, shape, and depth indicated, but never less than 4'-0" inside diameter.
- E. Concrete Brick Units: ASTM C 55, Grade N Type I-moisture controlled, normal weight, of same grade, type and weight as block units, nominal modular size of 3 5/8-inches x 7 5/8-inches x 2 1/4-inches
- F. Manhole Barrel: Precast polyethylene in accordance with ASTM D 1248. Nominal cylinder internal diameter shall be 48-inches and shall be designed to accept concrete filled polyethylene manhole lids and standard cast iron frames with lid or grate. Manholes shall have compressive strength that meets ASTM D 2412 standards. Acceptable Manufacturers: Advanced Drainage Systems (ADS) or approved equal.
- G. Mortar and Grout: Mortar for finishing and sealing shall be Class "C". Honeycombing less than 2-inches deep shall be repaired using Class "D" mortar.
- H. Brick Transition Reinforcement: Formed steel 8-gauge wire with galvanized finish.

2.2 COMPONENTS

- A. Lid and Frame: ASTM A 48, Class 30B heavy duty cast iron construction, machined flat bearing surface, removable lid, closed or open as indicated on Construction Drawings, sealing gasket, minimum total weight of 475 pounds manufactured by Neenah Foundry Company, East Jordan Iron Works, or approved equal.

2.3 CONFIGURATION

- A. Barrel Construction: Concentric with eccentric cone top section.
- B. Shape: Cylindrical
- C. Clear Inside Dimensions: 48-inches diameter minimum or as indicated on Construction Drawings.
- D. Design Depth: As indicated on Construction Drawings.
- E. Clear Lid Opening: 30-inches minimum
- F. Pipe Entry: Provide openings as indicated on Construction Drawings
- G. Main and Lateral Pipes: Neatly cut off main and lateral pipes flush with inside of manhole or inlet where they enter structure walls. Point up irregularities and rough edges with nonshrinking grout.
- H. Inverts: Shape inverts for smooth flow across structure floor as indicated on Construction Drawings. Use concrete and mortar to obtain proper grade and contour. Finish surface with fine textured wood float.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify items specified by other Sections are properly sized and located.
- B. Verify that built-in items are in proper location and ready for roughing into work.
- C. Verify that the excavation for manholes is correct.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves as indicated on Construction Drawings.

3.3 PLACING PRECAST MANHOLE BARREL SECTIONS

- A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
- B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
 - 1. After completion of slab foundation, lower first joint of manhole barrel into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert. Pour invert immediately after setting of first section of manhole barrel.
 - 2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer's recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.
- C. Set cover frames and lids level without tipping, to correct elevations. Utilizing pre-cast rings, or brick and mortar may achieve final rim elevation. Maximum limit, 4 courses.

3.4 CAST-IN-PLACE MANHOLE CONSTRUCTION

- A. Cast-in-place to be in accordance with Section 03 3000. Utilize steel forms.
- B. Place base pad to proper elevation and location and pour monolithically with invert. Base to support pipe to first joint.
- C. Deposit concrete in evenly distributed layers of about 18 inches, with each layer vibrated to bond to preceding layer.
- D. Place gasket between all joints and paint exterior of manhole within 5' of the joint with mastic waterproofing.
- E. Place precast concrete cone.
- F. Set section cover frames and lids level without tipping, to correct elevations. Utilizing pre-cast rings, or brick and mortar may achieve final rim elevation. Maximum limit, 4 courses.

3.5 MASONRY MANHOLE BARREL CONSTRUCTION

- A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- B. Lay masonry units in running bond. Course 3 brick units and 3 mortar joints to equal 8 inches.

- C. Form flush mortar joints
- D. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- E. Install joint reinforcement 16 inches on center
- F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening
- G. As work progresses, build in fabricated metal items
- H. Cut and fit masonry for pipes as specified herein
- I. Set cover frames and covers level to correct elevations without tipping.

END OF SECTION

SECTION 33 4000

STORM DRAINAGE

PART 1 GENERAL

These specifications are provided as a supplement to the governing jurisdictional authority's standards and specifications. These specifications shall have precedence when no other governing guideline exists.

1.1 SECTION INCLUDES

- A. Site storm sewer drainage piping, fittings, accessories, and bedding.
- B. Connection of building storm water drainage system to municipal storm sewers.
- C. Catch basins, paved area drainage, site surface drainage, and stormwater detention facilities.

1.2 RELATED REQUIREMENTS

- A. Section 31 2316 – Trenching and Backfill
- B. Section 31 2500 – Erosion and Sedimentation Control
- C. Section 33 3913 - Sewer Manholes, Frames, and Covers
- D. Section 03 3000- Cast-In-Place Concrete (See Arch/Bldg. Specs)
- E. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - 1. M36 Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Under Drains
 - 2. M190 Bituminous Coated Corrugated Metal Culvert Pipe and Arches
 - 3. M252 Corrugated Polyethylene Drainage Tubing, 3 to 10-Inch Diameter
 - 4. M294 Corrugated Polyethylene Drainage Tubing, 12 to 48 Inch Diameter
 - 5. MP7-97 Corrugated Polyethylene Drainage Tubing, 54 to 60 Inch Diameter

1.4 American Society for Testing and Materials (ASTM) latest edition

- 1. A74 Cast Iron Soil Pipe and Fittings
- 2. A185 Steel welded Wire Fabric, Plain, for Concrete Reinforcement
- 3. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- 4. A746 Ductile Iron Gravity Sewer Pipe
- 5. C 76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- 6. C150 Portland Cement
- 7. C206 Finished Hydrated Lime
- 8. C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- 9. C478 Precast Reinforced Concrete Manhole Sections
- 10. C564 Rubber Gasket for Cast Iron Soil Pipe and Fittings
- 11. C969 Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
- 12. D 3034 Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
- 13. D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- 14. D3350 Polyethylene Plastic Pipe and Fitting Materials
- 15. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

- B. American Concrete Institute (ACI)
 - 1. ACI 301 Structural Concrete for Buildings

1.5 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide shop drawings for precast inlets, catch basins and junction boxes.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.

1.6 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.7 PROJECT CONDITIONS

- A. Coordinate work with termination of storm sewer connection outside building including connection to municipal storm sewer system.

PART 2 PRODUCTS

2.1 STORM SEWER PIPE MATERIALS AND FITTINGS

- A. Reinforced Concrete Pipe (RCP): ASTM C 76, Class III, wall B (Class V under Railroads) except as noted on Construction Drawings, installed with flexible plastic, bitumen gaskets at joints.
 - 1. Gaskets: Joint material for RCP shall be rubber gasket conforming to the requirements of ASTM C443
 - 2. Flared end sections shall be Class 1
- B. High Density Polyethylene Pipe (HDPE) Smooth Interior/Annular Exterior: AASHTO Designation M252 Type S, M294 Type S and MP7-97 Type S. Only permitted when specifically indicated on Construction Drawings. Pipe shall be installed in strict accordance with pipe manufacturer's installation guidelines.
 - 1. Pipe Joints and fittings shall conform to AASHTO M252 and M294, ATSM F477.
 - 2. Acceptable manufacturers: Advanced Drainage Systems, Inc. (ADS), HANCOR, INC., or approved equal.
- C. Spiral Rib Metal Pipe Type 1R: ASTM A 760 Type 1R. Galvanized, aluminized, or bituminous coated as specified on Construction Drawings. Only permitted when specifically indicated on Construction Drawings. Pipe ends shall be re-corrugated and installed with semi-corrugated Hugger-type bands and "O" ring gaskets in accordance with pipe manufacture's installation requirements.
 - 1. Acceptable manufacturers: CONTECH, INC. "ULTRA FLOW or ULTRA FLO II", Caldwell Culvert Co. "Smooth Rib", or approved equal.
- D. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, rated SDR 35, continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification. Only permitted when specifically indicated on Construction Drawings.
 - 1. Pipe joints: Joints for PVC shall conform to ASTM D 3212 using restrained gasket conforming to ASTM F477.

- E. Corrugated Steel (Metal) Pipe (CSP or CMP): ASTM A 760, 16 gauge unless another gauge is indicated on Construction Drawings. Galvanized, aluminized (Type 1R), or bituminous coated as specified on Construction Drawings. Only permitted when specifically indicated on Construction Drawings. Corrugated steel pipe may be round pipe, arch pipe, or slotted drainpipe as indicated on Construction Drawings. Slotted drainpipe shall have 1.75-inches wide drain waterway openings and 6-inches minimum height drain guide
 - 1. CSP, bands and appurtenances shall be uniformly coated inside and outside with a 0.05 inch minimum thickness bituminous coating in accordance with AASHTO M190.
 - 2. CSP shall be supplied with paved inverts or fully lined to provide a smooth interior, smooth flow lining only as indicated on the construction drawings.
- F. Ductile Iron Pipe (DIP): shall conform to ASTM A746
 - 1. Fittings shall be cast iron conforming to ASTM A74
- G. Joint material for DIP shall be a rubber gasket conforming to the requirements of ASTM C564 for compression joints.
- H. Subdrains: shall be perforated, PVC or Flexible corrugated plastic pipe as specified herein of the size indicated on the construction drawings.

2.2 INLETS, CATCH BASINS AND JUNCTION BOXES

- A. Lid and frame per details shown on Construction Drawings.
- B. Pedestrian-safe grates are required in high-traffic pedestrian areas. Acceptable products include: Neenah R-1881 Series Narrow-Slotted Grates; East Jordan Iron Works V-57xx-80 Series grates; Bass & Hays Foundry VFG Pedestrian Rated Series.
- C. Structure construction in accordance with details shown on Construction Drawings and in accordance with Section 33 3913.
- D. Cast-In-Place concrete for drainage structures including: manholes, inlets, catch basins, collars, support blocks, headwalls and paved ditches shall conform to ACI 301 and applicable reference specification therein and the following:
 - 1. Compressive Strength – 3500 psi at 28 days.
 - 2. Reinforcement – ASTM A615, grade 40 or 60 deformed reinforcing bars. Or A185 for wire fabric
 - 3. Cement Mortar used for paving inverts, filling lift holes, joints, patching and anchoring castings shall consist of one part portland cement, type I, ASTM C150, 1/4 part hydrated lime, ASTM C206 and 2-1/2 parts clean, well-graded sand and water free of suspended matter, alkali, and containing no industrial or domestic waste.

2.3 ATHLETIC FIELD TRENCH DRAINS

- A. ACO sports series or approved equal with locking galvanized steel grate and self sloping invert.

2.4 TRUCK DOCK TRENCH DRAIN

- A. Portland cement concrete cast-in-place trench drain with East Jordan Iron Works bolted grate model V-7321 or approved equal as shown on the plans.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage piping or impede consistent backfilling or compaction.
- C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 31 2316.

3.4 INSTALLATION - PIPE

- A. The pipe shall be inspected for defects and cracks before being carefully lowered into the trench, piece by piece. Any defective, damaged or unsound pipe or any pipe that has had its grade disturbed after laying shall be taken up and replaced. Open ends shall be protected with a stopper to prevent earth or other material from entering the pipe during construction. The interior of the pipe shall be free from dirt, excess water and other foreign materials as the pipe laying progresses, and left clean at the completion of the installation.
- B. Installation shall commence at the lowest point for each segment of the route. RCP shall be laid with the groove or bell end upstream. Riveted CSP shall be placed with the inside circumferential laps pointing downstream. Applying bituminous material conforming to AASHTO M190 shall repair damaged bituminous coating on CSP.
- C. Lay pipe to the required line and slope gradients with the necessary fittings, bends, manhole, risers and other appurtenances placed at the required location as noted on Construction Drawings. Trim excess pipe protrusions within the receiving pipe or structure. Grout all field connections and connections to structures.
- D. Do not displace or damage pipe when compacting.
- E. No pipe shall be laid in water or when trench conditions are unsuitable for such work.
- F. Joints:
 - 1. Joints shall be constructed as described herein and in accordance with manufacturers installation instructions with the intent that they be made watertight.
 - 2. For RCP, the joint surface shall be cleaned and washed with water, if necessary, before the joints are made. For tongue and groove joints in smaller sizes, butting the inside of the bell with a cement mortar before joining shall make the joints. The inside joint can be wiped clean of excess mortar by brush or a squeegee drawn through the pipe as the laying operations progress. In the larger diameters, which permit the entry of a man, an annular space is provided between pipe sections which shall be completely filled with mortar and finished off smooth with the inside surface of the pipe.
 - 3. CSP shall be joined by standard corrugated connecting bands. Care shall be used to keep dirt or gravel out from between the pipes and band so that corrugations fit snugly. While being tightened, the bands shall be tapped with a mallet to take up slack and insure a tight joint.
 - 4. PVC fittings shall be attached to the pipe by solvent welding according to the manufacturers recommendations.

3.5 INSTALLATION - CATCH BASINS, INLETS, AND JUNCTION BOXES

- A. Precast Sections:
 - 1. Precast section with bases shall be installed in accordance with Section 31 2316 and 33 3913 or as shown on construction drawings.
 - 2. Pipe openings shall be aligned to that of the pipe entering and leaving the manhole, etc. Pipe shall be properly aligned with connections to manholes, etc. as shown on the construction drawings.
- B. Cast-In-Place sections shall be as shown on the drawings and in accordance with Section 03 3000.
- C. Form bottom of excavation clean and smooth to correct elevation.
- D. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.
- E. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on Construction Drawings.
- F. Invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Invert channels and structure bottoms shall be shaped with cement mortar. Changes in size and grade of invert shall be made gradually and evenly. Changes in direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
- G. Frames and Covers:
 - 1. Frames and covers shall be set to the proper elevation. The frames shall be firmly embedded in mortar approximately 1 inch thick and aligned to fit the top section of the structure.
 - 2. Bricks set in mortar used to adjust the frame to finished grade shall be limited to no more than four courses.
- H. Adjustment rings used to make adjustments in grade shall be made with the initial ring embedded in mortar and the exterior of the rings parged with mortar not less than 1/2 inch thick. No adjustment made in this manner shall exceed 8 inches.
- I. Concrete cradles shall be constructed as shown on the construction drawings and as needed when crossing over and under sewer pipe or utility lines. Concrete is to be 3600 psi mix with a minimum thickness of 6 inches.

3.6 SUBDRAINS

- A. Subdrains shall be installed in accordance with the details and at the locations shown on the construction drawings

3.7 INSPECTION AND TESTING

- A. General
 - 1. Storm sewer systems and culverts, upon completion or at such time as directed, shall be cleaned, inspected and tested. The system or culvert shall have a true grade and line. Actual elevations shall be within 0.08 feet of the elevations given on the construction drawings.
 - 2. After completion of the Work, or any part thereof, the job shall be tested to determine that it has been installed in accordance with the construction drawings and specifications. In general, the Work shall prove to be in good condition, installed in accordance with the construction drawings and specifications and ready for use.
- B. Cleaning and Testing

1. The contractor is to visibly inspect and remove all debris and obstructions from storm pipe. All storm pipe is to be tested for infiltration and exfiltration by hydrostatic testing per ASTM C969. All manholes and pipe shall meet ASTM C969 leakage criteria.
 2. All storm sewer lines constructed of HDPE or PVC shall be TV tested for line & grade and damage as may have been caused by other construction. Appropriate repairs shall be made by the Contractor.
- C. Alignment Test
1. After backfill has been placed and compacted to a depth not less than one foot above top of pipe, a visual inspection shall be made by flashing a light between manholes. Any displacement or misalignment of invert shall be corrected.

END OF SECTION



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