DIVISION 20 - GENERAL MECHANICAL

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 200200

OPERATION AND MAINTENANCE MANUAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Operation and Maintenance Manual.

1.3 SUBMITTALS

A. General: Comply with Section 20 05 00 and Division 01.

B. Preliminary O&M: Submit preliminary review O&M manual for review.

C. Final O&M: Submit Final O&M manuals per Division 01.

PART 2 - PRODUCTS

2.1 GENERAL

A. General Contents: A maintenance manual shall be compiled containing maintenance and operating information and maintenance schedules for all project mechanical systems. See Division 01 for quantities, organization, format, and other requirements; meet additional requirements as specified herein.

B. CD Electronic Copy: Shall contain pdf open format copies of the entire O&M manual, pdf open format copies of record drawings, and ACAD files for record drawings where ACAD shop drawings or ACAD record drawings are required (see individual specifications Sections for requirements). Files shall be bookmarked by section and by product. Drawings shall be bookmarked and labeled by sheet number and name.

2.2 SUBMITTAL DATA AND TECHNICAL O&M DATA

A. Submittal Data:
   1. General: Provide a copy the submittal data (clearly identified and marked to suit each item). Note: The submittals are not retained by the Owner and a copy is therefore required in the O&M.
   2. Product Data: Manufacturer’s technical product data, with manufacturer's model number, description of the equipment, equipment capacities, equipment options, electrical power voltage/phase, special features, and accessories. Label data sheets with same designation as used on contract documents. Provide for all items requiring maintenance and for items that may require replacement over a 30-year period or be revised due to an Owner building improvement.
   3. Shop Drawings: Provide copy of final shop drawings as approved for each area where shop drawings were required to be submitted.

B. Technical O&M Data: Provide for each equipment or item requiring maintenance. Label O&M data to clearly indicate which equipment on the project it applies to (use same designation as used in the Contract Documents). Data to include:
   1. Manufacturer's operating and maintenance manuals and instructions.
   2. Itemized list of maintenance activities and their scheduled frequency.
   3. Maintenance instructions for each maintenance activity.
   4. Manufacturer's parts list.
   5. Manufacturer's recommended lubricants.
   6. Size, quantity and type of filters required (as applicable).
   7. Size, quantity and type each belts unit requires (as applicable).
   8. Size, quantity and type of fuses (as applicable).
   9. Control system wiring diagrams and schematics.
   10. Control sequence descriptions with setpoints and range of adjustments.
   11. Description of unique devices/controls/programs specific to this system.

C. Sources: Provide names, addresses, and phone numbers for local manufacturer's representative, service companies, and parts sources for mechanical system components.

D. Start-Up Reports: Include copies of all equipment and system start-up reports.

E. Balancing Report: Include a full copy of the balancing report under a dividing tab for the specification section (or building system) where this work is specified. Where balancing is provided by others, obtain from the balancer a copy of the report to insert in the O&M's.

2.3 MAINTENANCE SCHEDULES

A. General: Provide Maintenance schedules with an itemized list of maintenance activities and their scheduled frequency (i.e., weekly, monthly, semi-annually, etc.) for item requiring maintenance.

B. Special Maintenance: List any critical maintenance items or areas requiring special attention.

C. Start-Up/Shut-Down: Provide normal start-up, operating, and shut-down procedures; emergency shut-down procedures; and (where applicable) seasonal shut-down procedures.

PART 3 - EXECUTION - NOT USED

END OF SECTION 200200

SECTION 200500

COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Division 23 - Heating, Ventilation, and Air Conditioning (HVAC) Systems.

1.2 WORK INCLUDED

A. General Mechanical System Requirements.

B. Mechanical System Motors.

C. Identification and Labeling.

1.3 DEFINITIONS

A. Abbreviations and Terms: Where not defined elsewhere in the Contract Documents, shall be as defined in RS Means Illustrated Construction Dictionary, Fourth Addition and in the ASHRAE Handbook of Fundamentals, latest edition.

B. "As required" means "as necessary to form a safe, neat, and complete working installation (or product), fulfilling all the requirements of the specifications and drawings and in compliance with all codes."

C. "Concealed" means "hidden from view" as determined when areas are in their final finished condition, from the point of view of a person located in the finished area. Items located in areas above suspended ceilings, in plumbing chases, and in similar areas are considered "concealed." Items located in cabinet spaces (e.g. below sinks) are not considered concealed.

D. "Coordinate" means "to accomplish the work with all others that are involved in the work by: directly discussing the work with them, arranging and participating in special meetings with them to discuss and plan the work being done by each, obtaining and completing any necessary forms and documentation required for the work to proceed, reaching agreement on how parts of the work performed by each trade will be installed relative to each other both in physical location and in time sequence, exchanging all necessary information so as to allow the work to be accomplished with a united effort in accordance with the project requirements".

E. "Finished Areas" means "areas receiving a finish coat of paint on one or more wall surface."

F. “Mechanical”, where applied to the scope of work, includes all project HVAC systems, and controls for these systems and all work covered by specification Divisions 20 and 23. Such work is shown on multiple drawings and is not limited to a particular set of sheets, or sheets prefaced with a particular letter.

G. The term "related documents" (as used at the beginning of each specification section), and the Specification Divisions and Sections listed with it, is only an indication of some of the specification sections which the work of that section may be strongly related to. Since all items of work relate to one another and require full coordination, all specification sections, as listed in the Table of Contents, shall be considered as being "related documents", and shall be considered (by this

reference) in the same manner as if they had all been listed under the term "related documents" in each specification section.

H. "Work included" (as used at the beginning of each specification section), and the items listed with it, is only an indication of some of the items specified in that Section and is in no way limiting the work of that Section. See complete drawings and specifications for all required work.

I. "Verify" means "Contractor shall obtain, by methods independent of the project Architect/Engineer and Owner, the information noted and the information needed to properly perform the work". Where used as "verify existing" the reference is to all existing items related to the work (i.e. piping systems, duct systems, electrical power, controls, structural conditions, space available, building construction type, etc.); the "verify" definition shall include "Confirm by means independent of any existing field labeling and independent of the Architect/ Engineer and Owner what the existing piping (or duct) system contains, sizes, what the flow direction is, what normal pressures/temperatures are, what other systems and areas the piping (or duct) is interconnected to; what the existing control voltages/signal types are by direct measurement; what the existing electrical power voltages and phases are by direct measurement; and additional field verification and coordination to ensure that compatible products are provided, correct connections made, and all work performed to allow for fully functioning systems." "Means independent of existing field labeling" shall include methods such as: the use of exterior pressurized sources to pressurize piping system lines, use of flow tests with dyes, physical tracing of piping and all connections to, electronic detection methods, electronic/electric line tracing, electrical measurements, physical disassembling of system, excavation or uncovering of concealed systems, use of insertion cameras and similar efforts.

J. "Substitution": As applied to equipment means "equipment that is different than the 'Basis of Design' equipment scheduled on the drawings (or otherwise indicated in the contract documents)".

1.4 GENERAL REQUIREMENTS

A. Scope: Furnish all labor, materials, tools, equipment, and services for all mechanical work. This section applies to all Division 20 and 23 specifications and to all project mechanical work. All mechanical equipment and devices furnished or installed under other Divisions of this specification (or by the Owner) which require connection to any mechanical system shall be connected under this division of the Specifications.

B. General: All work shall comply with Division 00, General Conditions, Supplementary Conditions, Division 01, and all other provisions of the Contract Documents.

C. Code:
1. Compliance: All work shall be done in accordance with all applicable codes and ordinances. Throughout the Project Documents, items are shown or specified in excess of code requirements; in all such cases, the work shall be done so that code requirements are exceeded as indicated. Comply with code accessibility requirements.
2. Documentation: Maintain documentation of all permits and code inspections for the mechanical work; submit documentation showing systems have satisfactorily passed all AHJ inspections and requirements.
3. Code Knowledge: Contractor and workers assigned to this project shall be familiar and knowledgeable of all applicable codes and ordinances. Code requirements are typically not repeated in the Contract Documents. By submitting a bid, the Contractor is acknowledging that the Contractor and workers to be utilized on this project have such knowledge.
4. Proof of Code Compliance: Prior to final completion, satisfactory evidence shall be furnished to show that all work has been installed in accordance with all codes and that all inspections required have been successfully passed. Satisfactory evidence includes signed inspections by the local code authority, test lab results, qualified and witnessed field tests, and related

acceptance certificates by local code authorities, and field notes by the Contractor as to when all inspections and tests occurred.

D. Complete Systems: Furnish and install all materials, appurtenances, devices, and miscellaneous items not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems. Not all accessories or devices are shown or specified that are necessary to form complete and functional systems.

E. Review and Coordination:
1. General: To eliminate all possible errors and interferences, thoroughly examine all the Drawings and Specifications before work is started, and consult and coordinate with each of the various trades regarding the work. Such coordination shall begin prior to any work starting, and continue throughout the project.
2. Suppliers: Suppliers of products shall review the documents to confirm that their products are suitable for the application and that all manufacturer's requirements and recommendations have been satisfactorily addressed in the Contract Documents. Where not addressed the supplier shall notify bidders and the Engineer prior to bidding to resolve any issue or include in their bid an adequate amount to resolve the issue.

F. Conflicts and Discrepancies: Notify the Architect/Engineer of any discrepancies or conflicts before proceeding with any work or the purchasing of any materials for the area(s) of conflict until requesting and obtaining written instructions from the Architect/Engineer on how to proceed. Where conflicts occur, the most expensive and stringent requirement (as judged by the Architect/Engineer) shall prevail. Any work done after discovery of such discrepancies or conflicts and prior to obtaining the Architect/Engineer's instructions on how to proceed shall be done at the Contractor's expense.

G. Drawings and Specifications: Drawings and specifications are complementary and what is called for in either is binding as if called for in both. The drawings are diagrammatic and show the general arrangement of the construction and therefore do not show all offsets, fittings and accessories which are required to form a complete and operating installation. Mechanical work is shown on multiple drawings and is not limited to a particular set of sheets, or sheets prefaced with a particular letter.

H. Offsets/Fittings:
1. Piping Systems: Include in bid all necessary fittings and offset to completely connect up all systems, maintain clear access paths to equipment, and comply with all project requirements. Offsets are required to route piping around building structural elements, roof slopes, mechanical systems, electrical systems, and numerous other items. Due to the schematic nature of the plans such offsets are typically not shown. Contractor is responsible to determine the quantity of offsets and fittings required, and the labor involved. No added payment or "extras" will be granted for the Contractor's failure to correctly estimate the number of offsets and fittings and labor required.
2. Duct Systems: Include in bid all necessary fittings, offsets, and transitions to completely connect all systems, maintain clear access paths, and comply with all project requirements. Offsets are required to route ductwork around building structural elements, roof slopes, mechanical systems, electrical systems, and numerous other items. Due to the schematic nature of the plans such offsets are typically not shown. Contractor is responsible to determine the quantity of offsets and fittings required, and the labor involved. No added payments or "extras" will be granted for the Contractor's failure to correctly estimate number of offsets, fittings, transitions and labor required. Contractor is advised that transitions are required at connections to all equipment, to all air inlets/outlets, crossing of beam lines, at crossing with piping, and similar locations.

I. Design: The level of design presented in the documents represents the extent of the design being furnished to the Contractor; any additional design needed shall be provided by the Contractor. All

design by the Contractor shall be performed by individuals skilled and experienced in such work, and where required by local code (or elsewhere in the documents) shall be performed by engineers licensed in the State where the project is located. Include in bid the costs of all such project design; including engineering, drafting, coordination, and all related activities and work. Such designs services are required for many building systems; including but not limited to ductwork at equipment, piping at equipment, hanger/support systems, temporary duct/piping systems, mechanical offsets/adjustments to suit other system, and for methods/means of accomplishing the work.

J. Special Tools: Furnish to the Owner one complete set of any and all special tools such as odd size wrenches, keys, etc. (allen wrenches are considered odd), which are necessary to gain access to, service, or adjust any piece of equipment installed under this contract. Each tool shall be marked or tagged to identify its use. Submit a written record listing the special tools provided, date, and signed by the Owner's representative receiving the tools.

K. Standards and References: Shall be latest edition unless a specific edition, year, or version is cited, or is enforced by the AHJ.

L. Warranties:
   1. General: Products and workmanship shall be warranted to be free from all defects, capable of providing satisfactory system operation, and conforming to the requirements of the Contract Documents. Include in the project bid all costs associated with project warranties to ensure that the warranty extends for the required period; possible project delays and failure by others to complete their work may cause the start of the warranty period to be delayed. The Contractor shall be responsible for increasing the warranty dates by corresponding amounts to provide the required warranty periods.
   2. Basic Project Warranty: As described in the General Conditions, Supplementary Conditions, and Division 01. See individual specification sections for specific warranty requirements. Start date and duration are as indicated in General Conditions, Supplementary Conditions, and Division 01. Where not indicated otherwise, the basic project warranty shall start at project substantial completion and be for one year.
   3. Special Warranties: See individual specification sections for special warranty requirements and extended warranty periods beyond the basic project warranty.

1.5 SUBSTITUTIONS

A. General: See Division 00 and 01 for information and requirements regarding substitutions. Manufacturers not scheduled on the plans or listed as “Acceptable Manufacturers” require prior approval and shall submit a substitution request form (see Division 01 for requirements and limitations). See Paragraph 2.01 this specification section regarding “Acceptable Manufacturers”.

B. Redesign:
   1. The Contract Documents show design configurations based on particular manufacturers. Use of other manufacturers' products (i.e. substitutions) from what is shown (or specified) may require redesign of mechanical, plumbing, controls, fire protection, electrical, structural, and general building construction to accommodate the substitution.
   2. Review the installation requirements for substitutions and provide redesign of all affected construction. The redesign shall be equal or superior in all respects to the Architect/Engineer's design (as judged by the Architect/Engineer), including such aspects as equipment access, ease of maintenance, utility connection locations, unit electrical requirements, noise considerations, unit performance, and similar concerns.
   3. Redesign shall be done by the Contractor and shall meet the requirements and have the approval of the Architect/Engineer prior to beginning work. Apply for and obtain all permits and regulatory approvals.

C. Construction Modifications: Provide all required construction modifications to accommodate the substituted products; this includes all mechanical, plumbing, controls, fire protection, electrical,

structural, and general building construction. Construction modification shall comply with code, specifications, and be equal to designed construction.

D. Costs: Cost of redesign, construction costs, and all additional costs incurred to accommodate substituted equipment shall be borne by the Contractor.

E. Submittals: In addition to other required submittals, submit shop drawings showing the redesign for substituted equipment; submittal shall include installation plans and sections, connecting services (i.e. ducts, piping, electrical) locations and routing, required service clearances, and related installation details. Submit data required by other disciplines to allow review of the impact of the substitution (i.e. weights, electrical).

1.6 QUALITY ASSURANCE

A. Experience: All work shall be performed by individuals experienced and knowledgeable in the work they are performing, and experienced with the same type of systems and building type as this project. By virtue of submitting a bid, the Contractor is acknowledging that workers to be utilized on this project have such experience and knowledge. Upon request of the Engineer, submit resumes showing the work history, training, and types of projects worked on, for individuals assigned to this project.

B. Code: Utilize workers experienced and knowledgeable with codes pertaining to their work; verify code compliance through-out the project.

C. ASME: All pressure vessels, pressure vessel safety devices, and pressure vessel appurtenances shall comply with the standards of, and bear the stamp of ASME.

D. Quality Assurance Checks: Prior to ordering products and making submittals, confirm the following for each:
   1. General: Product is suitable for the intended purpose and complies with the Contract Documents.
   2. Manufacturer: Product's manufacturer is listed as an acceptable manufacturer in the Contract Document’s or a substitution request (where allowed) has been submitted and the manufacturer has been listed as acceptable.
   3. Electrical (for products requiring electrical power):
   4. Product is for use with the voltage/phase as indicated on the electrical plans (or for the electrical circuit the item will be connected to).
   5. Product's ampacity requirements (MCA) do not exceed that indicated on the electrical plans (or for the electrical circuit the item will be connected to).
   6. Weight: Product's weight is no greater than that indicated.
   7. Space Verification: Product will fit in the space available, and along the path available to install the item, will have adequate service clearances, and will not impede on any clearances required for other items in the space the item will be located.
   8. Installation: A suitable method for installing the product has been selected which meets the project schedule and other requirements.
   9. Lead Time: The product's fabrication, shipping, and delivery period meets the project schedule requirements.
   10. Substituted Equipment: Where equipment is not the basis of design confirm all requirements for substituted equipment have been met and shop drawings of construction revisions have been (or are being) prepared.
   11. Controls: Item is compatible with the controls it will be connected to and has been coordinated with the firm providing the project control work.
   12. Listing: Item is Listed when required to be as such. And if the item is to be installed as part of a Listed system or assembly, it is compliant with the Listing of the overall system or assembly.

E. Check-Out: The Contractor shall be responsible to verify that proper installation and proper connections have been provided for all mechanical work. Contractor shall provide installation checkout, start-up services, and perform a thorough check of all mechanical systems to verify proper installation and operation. Contractor shall operate all items multiple times under varying conditions to confirm proper operation. Contractor shall submit a checklist listing all equipment, fixtures, and similar items furnished on this project, with a date and initials indicating when the item was checked, a list of what was checked, and by whom. Such check shall, as a minimum utilize documents provided by the equipment manufacturer. Such a check-out is in addition to any commissioning activities specified (unless noted otherwise).

1.7 SUBMITTALS - GENERAL

A. Variations: Only variations that are specifically identified as described herein will be considered. Provide with the submittal (in addition to other information required): description of the proposed variation, entity who is proposing the variation, why the variation is being proposed, any cost changes associated with the variation, and any other pertinent data to allow for review. Failure to submit information on the variation as described will result in the submittal review being conducted without considering the variation.

B. Quality Assurance: By submitting an item for review, the Contractor is claiming that all “Quality Assurance Checks” (see paragraph 1.06 this specification Section) have been performed and satisfactorily passed and no further comment from the submittal reviewer is required for the “Quality Assurance Checks”.

C. Product Submittals - Information Required:
1. Manufacturer's catalog information, containing product description, model number, and illustrations. Mark clearly to identify pertinent information and exact model and configuration being submitted.
2. List of accessories and options provided with product.
3. Product dimensions and clearances required.
4. Product weight.
5. Submittal identified with product name and symbol (as shown on the drawings or written in the specifications) and specification Section and paragraph reference.
6. Performance capacity and characteristics showing compliance with the Contract Documents.
7. Manufacturers and local manufacturer's representative names, addresses, and phone numbers.
8. For equipment requiring piping or duct connections:
   a. Type of connections required.
   b. Size and locations of connections.
9. For electrically operated equipment:
   a. Number and locations of electrical service connections required.
   b. Voltage required.
   c. Fuse or circuit breaker protection requirements.
   d. Motor starter requirements; if motor starter is furnished with the equipment, submit product information on motor starter.
10. For equipment requiring control connections:
   a. Type of control signals required.
   b. Control communication protocol.
   c. Information on control devices furnished with equipment.
   d. Location of control connections.
11. Manufacturer's installation instructions.
12. See each specification Section for additional submittal requirements.

D. Shop Drawing Submittals: Provide for the following systems:
1. HVAC control systems.

2. For any parts of any system which are to be installed differently than as shown on the drawings.
3. Construction revisions to accommodate Substituted Equipment.
4. Other areas/work as noted in the Contract Documents.
5. For those systems requiring shop drawings, reference system's specification Section for additional requirements.

1.8 RECORD DOCUMENTS

A. Field Record Drawings: Maintain a set of full size contract plans at the project site upon which all changes from the as-bid plans are noted. Plans shall be maintained clean, dry and legible; with information recorded concurrent with construction progress. These plans shall also include actual locations (with dimensions) of all underground and concealed mechanical systems. Connection points to outside utilities shall be located by field measurements and so noted on these record drawings. All addenda, change order, field orders, design clarifications, request for information, and all other clarifications and revisions to the plans shall also be made a part of these record drawings. Plans shall be available for weekly review by the Architect/Engineer. Label drawing “As-Builts” with date, name of Contractor, and name of individual overseeing the work.

B. Final Field Record Drawings Submittal: Deliver to the Architect/Engineer the original Field Record drawings and one full size copy.

1.9 PRODUCT HANDLING, PROTECTION AND MAINTENANCE

A. Protection:
1. Protect all products from contamination, becoming unclean, and from damage of any kind and whatever cause; when being handled, in storage, and while installed, until final project acceptance.
2. Completely cover fixtures, motors, control panels, equipment, and similar items to protect from becoming unclean and damage of any kind.
3. Protect premises and work of other trades from damage due to Mechanical work.

B. Openings: Cap all openings in pipe, ductwork and equipment to protect against entry of foreign matter until all work that could cause unclean conditions or damage is complete (including work that has dust or fumes associated with it). Caps shall be of sufficient strength and seal integrity to prevent entry of water or fumes for the most extreme conditions they may be exposed to (i.e. high velocity water spray, high winds, concrete splash, etc.)

C. Storage: Provide properly conditioned and sheltered storage facilities for products to prevent damage of any kind and to maintain new condition. Provide adequate venting arrangements to avoid condensation damage.

D. Operation and Maintenance:
1. General: Inspect products periodically to confirm conditions and maintenance needs. Keep records of inspections and (upon request) forward to the Architect/Engineer prior to project final acceptance. Operation and Maintenance shall be in accordance with manufacturer's written procedures and recognized best maintenance practices. Keep records of maintenance and (upon request) forward to the Architect/Engineer prior to project final acceptance.
2. Stored Products: Provide maintenance (i.e. equipment rotation, lubrication, flush, cleaning, etc.) and inspection on products while stored to maintain new condition.
3. Installed Products: Provide maintenance and inspection of products and operate mechanical systems until substantial completion or specified Owner Instruction has been provided (whichever is later). Maintenance shall include all labor and materials and all manufacturers’ recommended maintenance (i.e. strainer cleaning, filter changes, bearing lubrication, belt tensioning, etc.). In addition to scheduled maintenance, review all

equipment periodically to allow detection of improper operation or any special maintenance needs; review shall be consistent with best practices for the product but in no case less than a site visit every two weeks. Document all maintenance activities.

E. Damaged Products: Damaged products shall be replaced with new. Where damage is limited to paint (or similar finish), the product may remain if the finish is restored to a new condition (as judged by the Architect/Engineer).

1.10 JOB CONDITIONS

A. Special Requirements:
1. Maintain emergency and service entrance usable to pedestrian and vehicle traffic at all times. Where trenches are cut, provide adequate bridging for traffic.
2. Coordinate startup and shutdown of all mechanical systems and utilities with related trades and the Owner's representative.
3. Coordinate all construction activities with the Owner's Representative and cooperate fully so as to minimize conflicts and to facilitate Owner usage of the premises during construction.
4. Provide temporary services to occupied areas to accommodate Owner's use during construction. All temporary work shall comply with same specifications as for new work and be of same quality.

B. Downtime Restrictions:
1. Contractor shall notify the Owner at least 72 hours in advance of any intended shut-down of any building services or systems and obtain Owner approval prior to proceeding.
2. Electrical power to the building shall not be interrupted at any one time for more than 15 minutes.

C. Schedule of Work: Arrange work to comply with schedule of construction, and so as not to violate any downtime restrictions, and to accommodate the Owner's scheduled use of the premises during construction.

1.11 ENGINEER FIELD REVIEWS AND TEST WITNESSING

A. General: Arrange construction schedule and notifications to the Engineer to accommodate Engineer’s schedule and the possibility of review times occurring up to 14 days after notification, and for the possible failure to satisfactorily pass Engineer’s reviews requiring revisions and re-reviews.

B. Notification: Notify Engineer at least 7 days in advance of readiness for reviews; arrange mutually agreed upon times for the reviews to occur.

C. Access: Provide ladders, any special tools and safety equipment to allow Engineer's access to areas and equipment. Remove and reinstall ceiling tiles, access panels, and similar items where requested to allow for reviews.

D. Review of Systems with Equipment:
1. Prior to Engineer’s review, system’s equipment shall have received specified start-up and be substantiated by a written report.
2. Prior to Engineer’s review, systems shall have been operating properly for at least five consecutive days prior to the scheduled review date.
3. Personnel shall be present to operate the system’s equipment and controls, and to vary system settings as directed by the Engineer to allow for a review of operation over a range of settings.

E. Re-Review Fees: The project budget allows for one review by the Engineer for specified reviews and witnessing. See Division 00 and 01 for compensation to the Engineer for required re-reviews.

1.12 REFERENCES

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

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. General: Any reference in the Specifications or on the Drawings to any article, device, product, material, fixture, form or type of construction by manufacturer, name, make, model number, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The manufacturers listed as Acceptable Manufacturers may bid the project for the items indicated without submitting a substitution request; however that does not relieve the products from having to comply with the Contract Documents.

B. Substitutions: Products by manufacturers listed as “Acceptable Manufacturers” (other than those listed as the “Basis of Design”) are considered substitutions and shall comply with the requirements for substitutions. See Paragraph titled “Substitutions” in Part 1 of this specification section.

C. Considerations: In reviewing a manufacturer for acceptance, factors considered (as compared to the specified item) include: engineering data showing item's capacity, performance, proper local representation of manufacturer, likelihood of manufacturer's future local support of product, service availability, previous installations, previous use by Owner/Engineer/Architect, product quality, availability/quality of maintenance and operation data, electrical requirements, capacity/performance, acoustics, physical dimensions, weight, items geometry and access requirements, utility needs, and similar concerns.

D. Limitations of the Term “Acceptable Manufacturer”: The listing of a manufacturer as an Acceptable Manufacturer does not necessarily mean that the products of that manufacturer are equal to those specified. The listing is only an indication of those manufacturers which have represented themselves as being capable of manufacturing, or have in the past manufactured, items equal to those specified. The burden to review products to confirm equivalency with the specified products is on the Contractor. The Architect/Engineer shall be the final judge as to whether an item is equal to that specified.

E. Quality: Products provided by Acceptable Manufacturers shall be equal to or superior to the specified manufacturer's item in function, appearance, and quality, and shall fulfill all requirements of the Contract Documents. The Architect/Engineer shall be the judge as to whether an item meets these requirements or not.

F. Manufacturer: To be considered as being made by a particular manufacturer, the product must be made directly by the manufacturer and have the manufacturer’s name (or nameplate with name) affixed to the product (or on the product container where direct labeling is not possible). Example: manufacture “A” is listed as an acceptable manufacture; manufacturer “B” is not listed as an acceptable manufacturer; manufacturer “A” owns “B”; products from “B” do not qualify as being made by an acceptable manufacturer by virtue of ownership.

2.2 PRODUCTS - GENERAL

A. Standard Products: Products shall be standard products of a manufacturer regularly engaged in the manufacture of such products. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The two year's experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Except that equipment changes made solely to satisfy code requirements, to improve unit

efficiency, or to comply with unique project requirements are not required to have two year prior operation.

B. Latest Design: Products shall be the latest design and version available from the manufacturer, including software. Discontinued products shall not be used.

C. Service Support: Qualified permanent service organizations for support of the equipment shall be located reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Manufacturer's Nameplate: Equipment shall have a manufacturer's nameplate bearing the manufacturer's name, address, model number, serial number, and additional information as required by code. Nameplate shall be securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Nameplate shall be of durable construction, easily read, with lettering minimum size 12 font.

E. Compatibility: All components and materials used shall be compatible to the conditions and materials the items will be exposed to. All items exposed to the weather shall be galvanized, or be of stainless steel or similar corrosion resistant material.

F. Sizes: Sizes indicated for products manufactured to standardized sizes (e.g. pipe, pipe fittings, valves, material gauges, etc.) are minimums. During bidding confirm that the sizes are available and meet project requirements. Where indicated sizes are not available provide the next larger available size; confirm this larger size will suit the construction and meet Contract Document requirements prior to ordering. Such size revisions are subject to Engineer’s review; indicate size revisions on the product submittal and why the size is being revised.

G. Non-Specified Items: Materials shown on the drawings but not specified shall be provided as shown and as required to suit the application illustrated and intended and shall be of commercial quality, consistent with the quality of similar type items provided on the project. Not all items shown on the drawings necessarily have a corresponding specification; such items shall be provided per this paragraph and so as to provide complete, finished, fully functioning mechanical systems.

H. Weights: Do not exceed the weights shown unless added structural supports are provided. Such supports shall meet the requirements of the project Structural Engineer. The Contractor shall bear all costs for all redesign and added supports to accommodate heavier equipment. The Contractor shall reimburse the Engineer for all time associated with all review and analyses regarding the use of equipment heavier than that indicated.

I. Temperature/Pressure Rating: All materials and components furnished shall be suitable for the temperature and pressures they will be exposed to. Contractor shall consider possible operating modes to ensure proper material ratings.

J. Standardization: All products of the same type shall be by the same manufacturer and have the same characteristics and features to allow for Owner's standardization.

K. Model Numbers: Any reference to a manufacturer’s "model number" is a reference to a manufacturer’s series number or type of product, and is not a complete "model number" in having all the necessary numbers/letters to convey all of the features, accessories, and options that are required. These series numbers are only meant to convey a type of product that may meet the project requirements. Where conflicts or discrepancies occur regarding a listed manufacturer’s series or “model” number and specified capacities or features, the more stringent and expensive shall prevail.

L. Application and Suitability: Products shall be designed and intended for: commercial application, for the use indicated, and be suitable for the operating conditions they will be exposed to. Firms supplying the products shall review the documents and related site and environmental data to

confirm compliance. By making product submittals and using products they are being represented as appropriate for the project and application shown.

2.3 ELECTRICAL

A. General: All electrical devices, wiring, products, and work shall comply with the Division 26 specifications and code. See drawings for building occupancy type, types of construction, and areas which may require special wiring methods or other electrical work.

B. Equipment: All equipment requiring power shall be factory wired to an equipment mounted junction box (or an accessible compartment with power terminals or electrical device) arranged to allow for connection of electrical power.

C. Overcurrent protection: Circuit breakers, circuit breaker disconnects, fuses, and other current limiting devices indicated to be provided, shall be rated to suit the maximum overcurrent rating of the item served, and have other ratings, as required by code. Circuit breakers for HVAC and refrigeration unit equipment shall be UL listed by HACR type.

D. Short Circuit Current Rating (SCCR): All equipment (or components) requiring the use of electrical power shall have a SCCR value to comply with code. The minimum rating shall be 65,000 Amps RMS Symmetrical unless a lower value is indicated on the plans or allowed by code. Where the Contractor wishes to utilize equipment having a lower rating, the Contractor shall be responsible to provide calculations substantiating that a lower SCCR is acceptable (and complies with code), or make revisions to the electrical system to accommodate the proposed equipment (or components).

E. Product Certification (Listing): Products which require connection to electrical power shall be certified (i.e. listed) by a Nationally Recognized Testing Laboratory (NRTL) and be labeled (in a conspicuous place) with such certification (or certification mark). Certification shall comply with code, OSHA Standards, and Authority Having Jurisdiction (AHJ) requirements. NRTL's shall be recognized as such by OSHA and the AHJ. Certification shall be for the complete assembly (approval of individual components is not acceptable). Field evaluations to obtain certification shall be performed by accredited product testing laboratories acceptable to the AHJ and Engineer, be performed in accordance with code, NFPA 791, recognized practices, and be labeled to identify the certification. Certification is not required where the AHJ does not require it.

2.4 MOTORS

A. General: Where a piece of equipment specified includes an electric motor, the motor shall be factory installed and mounted. Motor starters and motor electrical disconnect switches shall be provided by the Contractor doing the work of the Section where the item was specified, unless specifically shown to be provided by Division 26 (or another Division). Wiring from the motor to motor starters and to electrical disconnects shall be by the Contractor doing the work of the Section where the item was specified, unless specifically shown to be provided by Division 26.

B. Acceptable Manufacturers: General Electric, TECO-Westinghouse, Reliance, Gould, Century, Baldor, U.S. Motors, Marathon, and acceptable manufacturers for the equipment (see individual specification sections).

C. Type: Motor type shall comply with code and applicable standard requirements and be configured to suit the application. Motors located indoors shall be open frame, drip-proof type, unless indicated otherwise. Motors located outdoors exposed to weather shall have corrosion resistant finish and shall be totally enclosed fan cooled (TEFC) or totally enclosed non-ventilated (TENV) type, unless indicated otherwise.

D. Listing: All motors shall be UL listed.

E. Efficiency: Motor efficiencies shall comply with code. Fractional horsepower motors shall be the electronically commuted (EC) type with speed control where noted and where non-EC motors are

not available which comply with code efficiency requirements. Motor power factor shall comply with code, local utility requirements, and as indicated. Provide added power factor correction devices as necessary to comply.

F. Sizing: Motors shall not be smaller than indicated and of adequate size to start and drive the respective equipment when handling the quantities specified without exceeding the nameplate full load current at the conditions indicated and for the expected operating conditions. If it becomes evident that a motor furnished is too small to meet these requirements as a result of the Contractor using substituted equipment or having revised the system arrangement, the Contractor shall replace it with a motor of adequate size at no additional cost to the Owner. Contractor shall also arrange with the Electrical Contractor to increase the size of the wiring, motor starter and other accessories as required to serve the larger motor at no additional cost to the Owner.

G. Service Factor: Minimum 1.15.

H. Variable Frequency Drive (VFD) Applications: Motors used with Variable Frequency Drives (VFD's) shall be rated for such use per IEEE standards and have shaft grounding protection.

I. EC Motors (ECM):
1. General: Electronically commutated type with integral inverter to convert AC power (of voltage/phase indicated) to DC power, and solid state circuitry to vary output power and speed of motor. Motor shall have permanently lubricated bearings with an L10 life of 100,000 hours at expected operating conditions. Motor shall have rotor position and rotation detection as required for operation.
2. Speed Range: Motor speed shall be controllable down to 25% of full speed.
3. Manual Speed Control: Provide with manual speed adjustment dial for motor speed control. Dial shall be motor mounted unless indicated otherwise, operable by a screwdriver or by hand. Motor mounted controls shall be factory wired. Remote mount dials shall be hand operable (i.e. no tools required), shall be for mounting on a standard 2 x 4 electrical junction box, and be able to be located up to 100 feet remote from the motor. Motor control wiring for remote mount dials shall be factory wired from the motor to an equipment mounted junction box (with field supplied wiring from this J-box to the remote dial).
4. EMCS Control: Motor speed shall be adjustable via a remote 0-10V input signal (unless noted otherwise) from the building EMCS. Control wiring shall be factory wired from the motor to an equipment mounted junction box. EMCS control is not required where not indicated to be provided or where not utilized as part of the control sequence.
5. Control Power: Provide with integral transformer, factory wired, as needed to power motor controls. Locate transformer at motor or equipment.

2.5 IDENTIFICATION AND LABELS

A. General: All piping, valves, and mechanical equipment shall be labeled. Labels in concealed accessible spaces shall be reviewed and verified by Architect/Engineer prior to being concealed.

B. Piping:
1. Type: Self-sticking colored identification markers, lettered to identify the pipe contents, and banded at each end with arrow tape indicating the direction of flow. Markers shall be similar and equal to Brady "System 1" and Seton "Opti-Code" markers. Spray painted stencil labeling is not acceptable. Some labels may be special order.
2. Identification Colors: Comply with ASME A13.1, and as follows:

Conveyed Material/System	Background	Letters
Condensate Drains	Green	White
Refrigeration	Black	White

3. Lettering: Lettering shall identify the material conveyed in each pipe and shall match the designation used on the plans, but without abbreviations.

4. Size: Size of letters and color field shall comply with ASME A13.1, repeated here for convenience:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
3/4 to 1-1/4 Inches	8 Inches	1/2 Inches
1-1/2 to 2 Inches	8 Inches	3/4 Inches
Over 2 Inches	12 Inches	1-1/4 Inches

5. Applications: Install on all piping at branches to indicate changes of direction, where pipes pass through walls and floors, on 20 foot centers or at least one in each room on each pipe. Markers shall be installed on all concealed accessible piping (i.e., piping above suspended ceilings, behind access doors, in accessible chases, etc.) near the point of access. Markers shall be installed so as to be easily read by a person standing on the floor.
6. Other Requirements: See other specification Sections for additional requirements.

C. Equipment:
1. Labels: Laminated plastic (or phenolic) material, 1/16-inch thick, with black surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Minimum 2-inch high (unless indicated otherwise or required due to equipment size) with length to contain required lettering. Label shall be pre-drilled and be mechanically fastened to the equipment. Prior to making labels, submit a list of all proposed labels.
2. Lettering: All caps, engraved on label, with equipment designation (same designation as used on Contract Drawings; e.g. HVAC-101, EF-22, CP-1A). Air handling equipment (i.e. VAV terminal units, fans, etc.) labels shall include the room names and numbers or area of building served (use final installed room designations). Where systems serve portions of the building (i.e. wings or floors), include on label the area served. Lettering shall be in multiple rows, with equipment label on top row. Equipment lettering to be 5/8-inch high; area served lettering to be 3/8-inch high (except that smaller lettering may be used if necessary to fit label size).
3. Application: All scheduled mechanical equipment shall be labeled. The label shall be located on a side of the equipment so as to be easily read, with the marking visible to a person standing at the access level near the equipment (assuming any necessary access to a concealed unit has been made).

D. Electrical Devices:
1. Labels: Minimum 1/4-inch high (unless indicated otherwise) lettering, all caps, engraved on laminated plastic or phenolic material, at least 1/16-inch thick. Laminated plastic (or phenolic) shall have black surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Label shall be pre-drilled and be mechanically fastened to the item; where mechanical fastening is not possible use 3M VHB double sided specialty tape No. 4945. Prior to making labels, submit a list of all proposed labels.
2. Lettering: Label shall identify the item served (using the same designation as indicated on the Contract Drawings), the source of power (by panel and circuit breaker), and comply with code.
3. Application: Variable frequency drives, motor starters, disconnects, contactors, relays and similar items which control power to equipment and system components shall be labeled. The label shall be located so as to be easily read.

E. Duct Access Doors:
1. Labels: Minimum 1-inch high (unless indicated otherwise) lettering, engraved on laminated plastic or phenolic material, at least 1/16th inch thick. Laminated plastic (or phenolic) shall have red surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Label shall be pre-drilled and be mechanically fastened to the duct access door. In lieu of laminate type, self-adhesive vinyl signs may be used.

2. Lettering: Label shall comply with code, and indicate the item being accessed (i.e. Exhaust Discharge Damper, Fire Damper, CO2 Sensor, etc.). Labels shall include the room names and numbers or area of building served; use final installed room designations.
3. Application: All duct access doors serving backdraft dampers, control dampers, items required by code, and control devices shall be labeled. Where these items are provided under Division 26, they shall be labeled by Division 26. Access door label is not required where it is readily obvious as to what is being accessed (e.g. duct coil where coil is easily seen). The label shall be located so as to be easily read, with the marking visible to a person standing at the access level near the access door (assuming any necessary access to a concealed label has been made).

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship: Furnish and install products to provide complete and functioning systems with a neat and finished appearance. If, in the judgment of the Architect/Engineer, any portion of the work has not been installed in accordance with the Contract Documents and in a neat workmanlike manner, or has been left in a rough, unfinished manner, the Contractor shall be required to revise the work so that it complies with the Contract Documents, at no increase in cost to the Owner.

B. Coordination: Coordinate the work with all trades that may be affected by the work to avoid conflicts and to allow for an organized and efficient installation of all systems.

C. Examination and Preparation: Examine installation conditions and verify they are proper and ready for the work to proceed. Verify compatibility of materials in contact with other materials, and suitability for conditions they will be exposed to. Do not proceed with the work until unsatisfactory conditions have been corrected. Prepare area to accept the work and prepare products for the installation.

D. Field Conditions: Check field conditions and verify all measurements and relationships indicated on the drawings before proceeding with any work. In verifying existing conditions, the Contractor shall verify by direct physical inspection, complete tracing out of systems, by applying test pressures, by excavation and inspection, use of pipeline cameras, and other suitable absolute certain methods to confirm the actual physical conditions that exist.

E. Openings and Cutting and Patching in New Construction:
1. Openings - General: The General Contractor shall provide all required spaces and provisions in structures of new construction for the installation of work of all other contractors or subcontractors.
2. Coordination: The Contractors doing work subject to Division 20 shall furnish to the General Contractor (in a timely manner) all needed dimensions and locations of openings to allow for these openings to be provided as the construction adjacent to the opening is being done.
3. Cutting and Patching: Cutting and patching of structures in place made necessary to admit work, repair defective work, or by neglect of contractors and subcontractors to properly anticipate their requirements, shall be done by the General Contractor at the expense of the contractors or subcontractors responsible. Work shall be done in a fashion to duplicate the results that would have been obtained had the work been properly sequenced.
4. Patching Materials: Patching shall be with materials of like kind and quality of the adjoining surface by skilled labor experienced in that particular trade.

F. Openings and Cutting and Patching in Existing Construction:
1. Openings--General: Provide all openings and cutting as needed to accommodate all work. Provide patching to restore all damaged and disturbed areas to pre-construction conditions (or better). The Contractor or subcontractor requiring the opening shall be responsible for

making that opening. The opening shall be made by skilled labor experienced in providing openings in the material being penetrated.

2. Areas To Be Cut and Patched: Wherever floors, walls, ceilings, plates, firestops and framing members are cut, these openings shall be substantially reinforced and sealed so as to maintain the strength and sealing ability of the element equal to that as if it had not been cut. All reinforcement/sealing shall satisfy the Architect/Engineer and comply with the governing codes. Such cut areas shall be patched and restored to a finished condition, equal to adjacent final finished areas that have not been cut.
3. Cutting of Structural Features: Make no cuts or alterations to any structural framing members without explicit consent of the Engineer, and then only under his direction. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. All required cutting to install material shall be accomplished with the use of saw cutting equipment.
4. Patching Materials: Patching shall be with materials of like kind and quality of the adjoining surface by skilled labor experienced in that particular trade.

G. Cleaning: Clean all products (whether exposed to view or not) of all construction debris, and other materials; grease and oil spots shall be removed with appropriate cleaning agents and surfaces carefully wiped clean. Where cleaning cannot restore items to new conditions, the item shall be replaced with new.

3.2 INSTALLATION

A. General: Work shall be in accordance with manufacturer's written installation instructions, code, applicable standards, and best construction practices.

B. Space Verification: Prior to ordering materials verify that adequate space exists to accept the products, along the installation path, and to allow for proper maintenance access. Select products that will fit the space available; some optional materials (i.e. fitting types, substituted manufacturers etc.) may not be suitable. Verification shall be by direct field measurement of the actual space available and use of manufacturer’s final submittal dimensions. Where the project involves new construction and long lead items and a time schedule not allowing for such direct field measurements, confirm in writing with all trades associated with building the space that adequate room is available. Review maintenance and service access space required and confirm requirements will be met. No submittals shall be made until such space verification work has been performed, and confirmed that adequate space is available. By virtue of making a submittal that Contractor affirms he has completed this verification.

C. Installation Locations:
1. General: Unless dimensioned locations for items are shown, select the precise location of the item in accordance with the Contract Documents, coordinated with other trades and item connection locations, and subject to the Architect/Engineer's review. No allowances will be granted for failure to obtain the Architect/Engineer's review, failure to coordinate the work, and failure to comply with Contract Document requirements.
2. Manually Operated Components: Valves, damper operators, on/off switches, keypads, controls, and other devices which are manually adjustable or operated shall be located so as to be easily accessible by a person standing on the floor adjacent to the item. Any such items which are not in the open shall be made accessible through access doors in the building construction. See individual specification sections for additional requirements.
3. Monitoring Components: Gauges, thermometers, instrumentation, and other components which display visual information (i.e. operating conditions, alarms, etc.), shall be located and oriented so as to be easily read by a person standing on the floor. Provide necessary brackets, hangers, remote read devices and accessories as needed. Equipment control panels and graphic displays furnished with equipment (or integral to equipment) shall be located to be easily accessible by a person standing on the floor adjacent to the equipment, and be located between 4-feet and 6-feet above the finished floor.

4. Installation Issues: If circumstances at a particular location make the accessible installation of an item difficult or inconvenient, the situation shall be discussed with the Architect/Engineer before installing the item in a location that will result in poor access.
5. ADA Accessibility: Locate items which are required to be ADA accessible in accordance with code (including but not limited to IBC, ICC A117.1 and local amendments) for accessibility; verify accessibility requirements with the AHJ.

D. Replacement and Maintenance: Install mechanical equipment to permit easy access for normal maintenance, and so that parts requiring periodic replacement or maintenance (e.g. coils, heat exchanger bundles, sheaves, filters, bearings, etc.) can be removed. Relocate items which interfere with access or revise item installation location, orientation, or means of access.

E. Building Access Doors: Provide access doors where indicated and where needed to provide access to valves, drains, duct access doors, and similar items requiring service or access that would otherwise be inaccessible. Consult architectural drawings and coordinate location and installation of access doors with trades which are affected by the installation. Access doors are typically not shown on the drawings. The Contractor shall review all construction details and types and locations of items requiring access to determine quantity and sizes of access doors required.

F. Rotating Parts: Belts, pulleys, couplings, projecting setscrews, keys and other rotating parts which may pose a danger to personnel shall be fully enclosed or guarded in accordance with Code, and so as not to present a safety hazard.

G. Dissimilar Metals: Provide separations between all dissimilar metals. Where not specified in another way, use 10 mil plastic tape wrapped at point of contact or plastic centering inserts.

H. Electrical Offsets: Provide offsets around all electrical panels (and similar electrical equipment) to maintain space clear above and below electrical panels to structure, and clearance of 3.5 feet directly in front of panel, except where indicated otherwise or required by code to be more. Such required offsets are typically not shown on the plans but are to be provided per this paragraph. Include in bid offsets for all systems near electrical panels.

I. Piping Through Framing: Piping through framing shall be installed in the approximate center of the member. Where located such that nails or screws are likely to damage the pipe, a steel plate at least 1/16-inch thick shall be installed to provide protection. At metal framing, wrap piping to prevent contact of dissimilar metals. At metal and wood framing, provide plastic pipe insulators at piping penetrations through framing nearest each equipment connection and on at least 32-inch centers.

J. Safety Protection: All ductwork, piping and related items installed by this Contractor that present a safety hazard (i.e., items installed at/near head height, items projecting into maintenance access paths, etc.) shall be covered (at hazardous area) with 3/4" thick elastomeric insulation and reflective red/white self-sticking safety tape. All sharp corners on supports and other installed items shall be ground smooth.

K. Equipment Access: Access to equipment is of utmost importance. Contractor shall apply extra attention to the location of pipe and duct routings and in coordinating all work so that equipment access and a clear maintenance pathway to equipment is maintained. Poor maintenance access will not be accepted. Contractor shall note that in essentially all areas piping and ducts need to run with slopes parallel to the roof.

L. Pressure Tests: Maintain documentation of all pressure (and leakage) tests performed on systems and submit with project closeout documents. Records shall contain (as a minimum): date of test, system name, description portion of system being tested, method of test, initial and final test pressures (or of measured leakage rates, as applicable), indication of test pass or fail, name and signature of individual performing (or documenting) the test, initials of independent witness of test.

3.3 PAINTING

A. General: Painting shall comply with Division 09 specifications regarding painting. Colors, in all cases, shall be as selected by the Architect/Engineer. Color samples shall be submitted to the Architect/Engineer for approval prior to painting.

B. The following painting shall be provided under Division 20:
   1. All exposed metallic surfaces (includes piping, ducts, hangers, conduits, etc.) provided by this Contractor (except equipment with factory finish or items specifically excluded) shall receive one coat of rust inhibiting primer and two (2) coats of selected finish paint.
   2. All exposed insulated surfaces provided by this Contractor (except where specifically excluded) shall receive one coat of primer and two coats of selected finish paint.
   3. The inside of all ductwork (including visible dampers, roof vents, insulation pins, and any visible metal) behind grilles, registers, diffusers, and louvers shall be painted flat black.

C. Items to be painted under Division 09:
   1. Exposed duct work in finished areas.
   2. Exterior mechanical equipment.
   3. Exposed piping in finished areas.

3.4 PENETRATION PROTECTION

A. Exterior and Watertight Penetrations: Where any work pierces the building exterior (or construction intended to be watertight) the penetration shall be made watertight and weatherproof. Provide all necessary products (e.g. caulking, flashing, screens, gaskets, backing materials, siding, roofing, trim, etc.). Where not detailed or indicated how to install submit shop drawings of the proposed methods. Flashing arrangements shall be per SMACNA Architectural Sheet Metal Manual unless noted otherwise. Caulking alone is not an acceptable means of sealing penetrations.

B. Equipment: Equipment or products located outdoors shall be watertight (except for provisions designed to intentionally accept water and having drain provisions) and shall be designed and intended by the manufacturer to be used outdoors at the project location. Where any work pierces the unit casing exposed to the outdoors the penetration shall be made watertight and weatherproof; provide all necessary products (e.g. caulking, flashing, gaskets, backing materials, etc.).

3.5 START-UP

A. General: Provide inspections, start-up and operational checks of all mechanical systems and equipment. Maintain documentation of all start-up work and submit with project closeout documents. See individual specification Sections for additional requirements.

B. Personnel: Inspection and start-up services shall be done by individuals trained in the operation, and knowledgeable with, the systems being started-up. Equipment start-up shall be by the manufacturer's authorized service representative where indicated (see individual specification Sections).

C. Scheduling and Agenda: Submit a proposed detailed start-up schedule with proposed dates and times at least 30 days prior to the earliest proposed system start-up. Revise dates and times as mutually agreed upon with trades involved, and witnesses, before submitting a final start-up schedule.

D. Witnessing: Start-up may be witnessed by the Engineer and Owner's representative (at their option). Notify the Engineer and Owner 7 days prior to the proposed start-up time.

3.6 OWNER INSTRUCTION

A. General: Provide instruction to the Owner on the operation and maintenance of all installed mechanical systems. Prior to instruction provide final Operation and Maintenance (O&M) manuals. Have copy of O&M manual and project drawings on hand during instruction.

B. Personnel: Instruction involving the general arrangement and overview of systems, including locations and connections of system components, shall be by individuals that were involved in the installation of these systems. Instruction on the operation and maintenance of products shall be by individuals trained and experienced in the installation, operation and maintenance of these products. Instruction shall be by the product manufacturer's authorized service representative where indicated (see individual specification Sections).

C. Scheduling and Agenda: Submit a proposed instruction schedule (with proposed dates and times) and an instruction agenda at least 30 days prior to the earliest proposed instruction period. Coordinate Owner and Architect/Engineer review and arrange mutually agreed upon instruction schedule and the instruction agenda, and submit a final instruction schedule and agenda. Organize instruction by sub-systems corresponding to the project specifications (or similar logical grouping).

D. Field Instruction:
   1. Scope: Provide on-site field instruction for each mechanical product requiring maintenance or expected to require repair in the next 10 year period. Provide individual instruction for each unique product, or where products of the same type vary appreciably from others (due to size, options, etc.). See individual specification sections for additional requirements.
   2. Overview: Show and explain the overall arrangement and locations of each mechanical system. Show the locations of all system major shut-off valves, location of major equipment components, routing of system mains, and related information.
   3. Operation: Demonstrate and explain normal start-up, normal shut-down, normal operation, normal settings, adjustments, signs of abnormal operation, emergency shut-down, safety concerns, and related information.
   4. Maintenance: Demonstrate and explain system maintenance requirements with references to the O&M Manual. Show how maintenance is performed, including how items are accessed, maintenance procedures, tools and parts required, and related information. Review typical repairs and explain how performed.

E. E. Occupant Training: Provide training to building occupants explaining systems and devices that they have access to or control of. Coordinate with Owner and other training activities.

END OF SECTION 200500

SECTION 200503

EXISTING SYSTEMS WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Review of Existing Conditions.

B. Cutting and Patching.

C. Deactivation and Cap-off of Systems.

D. Mechanical Demolition and Disposal.

1.3 DEFINITIONS

A. “Remove”, "demo", and "demolish" mean "Remove and legally dispose of item and item accessories; except where indicated to be reinstalled, salvaged, or some other required work is indicated."

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials: All materials used for capping, temporary piping, repairs, reconnecting, reinstalling, and related work shall be same as specified for new systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Protection: Existing items not being demolished shall be protected against damage. Where necessary to prevent damage or necessary to accomplish other work, items shall be disconnected and moved to a suitable protective storage location during the project and then reinstalled to their original location.

B. Utilities and Building Systems: Maintain existing utilities and building systems in service (unless indicated otherwise) and protect from damage during project. Where utilities or building systems must be shut-off to accomplish the work, see drawing notes, Section 20 05 00, and Division 01 for downtime limitations and Owner coordination and notification requirements; coordinate interruptions with other trades.

C. Equipment and System Contents: Equipment and systems contain fluids that are typical for such items (e.g. HVAC units contain refrigerant, oils, etc.) and require special removal methods and disposal.

D. Existing Items:

1. Information and Field Verification: Routing, locations, and identification of existing items on plans are approximate and are limited. The relative location of systems shown on plans has not been verified, and is schematic only. Field verify locations, contents, and flow direction of all piping and ducts prior to performing any work associated with such systems (see also Section 20 05 00). Do not rely on existing labeling of systems; such labeling shall be considered wrong until verified by other physical evidence.
2. Work Around: Existing building cavities (ceiling spaces, walls, etc.) contain a multitude of systems (e.g. conduit, wiring, fire suppression, light fixtures, low voltage system components, piping, ducts, etc.) typical for buildings of the type of this project. Added effort is required to identify and locate these systems, to work around such systems, and to temporarily disconnect and reconnect (and possibly remove and store) various building components to accommodate the work. Existing building elements will also require the work to be installed in smaller sections (i.e. shorter pipe or duct lengths) than normally possible, and to make system connections in awkward or cramped locations.

E. Patching: Patch all wall/floor/ceiling/roof openings left by removal of existing items where wall/floor/ceiling/roof is to remain. Patch with materials and workmanship so as to match finish of adjacent undisturbed area, and to provide conditions equivalent to the original new construction.

F. Disposal: Dispose of all demolished items and all waste materials off site in accordance with code and legal requirements.

G. Owner's Salvage: Owner has first right to all items shown to be demolished. All items not wanted by Owner, and not indicated to be salvaged for reuse, shall be removed by the Contractor.

3.2 REVIEW OF EXISTING CONDITIONS

A. General: Provide field investigation of all systems and existing conditions to confirm extent of demolition, routing of existing systems, existing building materials of construction, mechanical system types and materials involved, areas where cutting and patching is required, site access, sizes of existing system components, and all other aspects of existing building and systems and their relationship to the Work.

B. Review Timing: Review existing conditions prior to bidding, again prior to commencing any work or ordering materials, and continually throughout the project.

C. Review for Space and Routing:
1. Review existing conditions (including dimensions) where equipment must be moved through to confirm adequate space and path.
2. Review existing conditions (including dimensions and locations of existing systems) where work will occur to determine impact on the locations and routing of new systems; include time to develop shop drawings and revisions to routing shown on the design drawings to accommodate existing conditions.

D. Construction Thickness: Where needed to perform the work, and to prevent damage to adjacent construction, verify the thickness of existing concrete floors and other elements by selective drilling or saw cutting.

3.3 DEMOLITION

A. General: Review site conditions and identify all demolition work; include in bid all costs for demolition and disposal. Coordinate all demolition work with other trades. Confirm items to be salvaged or reused, and overall demolition scope.

B. Scope: Not all items to be demolished are necessarily shown on the drawings, but are covered by notes and specifications. In addition to demolishing items indicated, demolish all associated items (unless indicated otherwise); this includes such items as supports, insulation, piping, drains, control

wiring/conduit, power wiring/conduit, and similar accessories. Demolish all utilities serving demolished items completely or back to active mains where mains are to remain active; assume such utilities extend at least forty feet from the demolished items (unless indicated otherwise). Demolish all mechanical items located in building elements which are being demolished (i.e. located in walls, chases, roof assemblies, etc.). Demolish items as required to accomplish the work.

C. Depth: Abandoned items, anchors, inserts, and other projections embedded in existing construction and not being concealed by new construction shall be removed to at least 1" below the adjacent finished surface, and the disturbed area patched.

D. Cap-Offs and Terminations:
   1. Permanent: Provide cap-off of all existing utilities and systems that are cut or served demolished items. All cap-offs shall occur in concealed locations (unless indicated otherwise). Cap-off's shall be of equivalent material as the item being capped and be insulated where the connected system was insulated or where doing so will reduce energy consumption or prevent condensation.
   2. Temporary: Provide temporary cap-off of all existing utilities and systems to allow continued use of all systems until the final system components are installed and connected.

END OF SECTION 200503

SECTION 200529

HANGERS AND SUPPORTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Pipe Hangers and Supports.

B. Duct Hangers and Supports.

C. Mechanical Equipment Anchors and Supports.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) Standards SP-58, SP-89, SP-69, and SP-90.

B. General: All methods, materials and workmanship shall comply with Code; including IBC, IMC, UPC, NFPA Standards, and ASME standards.

1.4 SUBMITTALS

A. General: Submittals shall comply with Section 20 05 00.

B. Product Data: Submit product data for all hangers, supports, and anchors. Data to include finish, load rating, dimensions, and applicable agency listings. Indicate application for all items by system type, size, and other criteria as appropriate to project.

C. Shop Drawings: Submit shop drawings for all supports that will be exposed in finished areas.

1.5 GENERAL REQUIREMENTS

A. Seismic: Provide adequate hangers, supports, anchors, and bracing to serve as seismic restraints. Seismic anchoring and bracing methods shall comply with SMACNA SRM, Mason SRG, and code. Seismic restraints system shall be able to withstand seismic forces as required by code; provide seismic restraint calculations as required by the AHJ.

B. Design and Manufacture: All pipe hangers and supports shall be designed and manufactured in accordance with MSS-SP 58.

1.6 REFERENCES

A. ADC: Air Duct Council - Flexible Duct Performance and Installation Standard, 5th Edition.

B. ASHRAE-F: American Society of Heating, Refrigeration, and Air Conditioning Engineers, Handbook of Fundamentals.

C. ASME B31.1: Power Piping.

D. ASME B31.9: Building Services Piping.

E. ASTM A36: Standard Specification for Carbon Structural Steel.

F. ASTM A108: Standard Specification for Steel Bar, Carbon and Alloy, Cold - Finished.

G. ASTM A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

H. ASTM A153: Standard specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

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

J. ASTM A907: Standard Specification for Steel, Wire, Epoxy - Coated.

K. ASTM A924: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.

L. IBC: International Building Code.

M. IMC: International Mechanical Code.

N. Federal Spec QQ-W-461H: Wire, Steel, Carbon (Round, Bare, and Coated).

O. Mason SRG: Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, Electrical Systems and Floor Mounted Equipment, 6th Edition.

P. MSS SP-58: Pipe and Hangers and Supports - Materials, Design and Manufacture.

Q. MSS SP-69: Pipe and Hangers and Supports - Selection and Application.

R. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.

S. MSS SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

T. SMACNA-DCS: HVAC Duct Construction Standards, 3rd Edition.

U. SMACNA SRM: Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition.

V. UPC: Uniform Plumbing Code.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Hangers and Supports: Grinnell, B-Line Systems, Unistrut, Erico, PHD, Basic-PSA, Pate, Caddy, Unisource, Metraflex, American Insulation Sales, Thermal Pipe Shields, Miro Industries.

C. Anchors: Rawplug, Phillips, Hilti, Michigan, Simpson, Fastenal, Grinnell, B-Line Systems, Unistrut, PHD, Basic-PSA, Metraflex.

2.2 GENERAL

A. Finish:

1. Indoor Applications: Electro-plated zinc in accordance with ASTM B 633, or hot-dip galvanized after fabrication in accordance with ASTM A 123; except that hanger straps may be formed from pre-galvanized steel.
2. Outdoor Applications: Hot-dip galvanized after fabrication in accordance with ASTM A 123, ASTM A 153, or ASTM A 653 (as applicable to item).

B. Identification: Steel pipe hangers and supports shall be stamped with the manufacturer's name, part number, and size.

C. Hanger Rods: Threaded hot rolled steel. Hanger rods shall be sized so that the total load imposed (including pipe or duct, insulation, hangers, and fluid) does not exceed the following:

Nominal Rod Diameter	Maximum Load
1/4 Inch	240 Pounds
5/16 Inch	440 Pounds
3/8 Inch	610 Pounds
1/2 Inch	1130 Pounds
5/8 Inch	1810 Pounds
3/4 Inch	2710 Pounds
7/8 Inch	3770 Pounds
1 Inch	4960 Pounds

D. Hanger Straps: Galvanized steel, minimum 1" x 22 gauge (except where required by Code to be heavier or noted otherwise), of lock-forming grade conforming to ASTM A924, G90 (minimum) galvanized coating conforming to ASTM A 653. Minimum yield strength of 30,000 psi. Straps shall be sized so that the total load imposed does not exceed the following:

Strap Size	Maximum Load
1" x 22 Gauge	230 Pounds
1" x 20 Gauge	290 Pounds
1" x 18 Gauge	380 Pounds
1" x 16 Gauge	630 Pounds
1-1/2" x 16 Gauge	990 Pounds

E. Beam Attachments: Constructed of malleable iron or steel, MSS standard types designed for clamping to building structural support beam. "C" clamp type shall have cup point set screws with locknuts and retaining straps. Center loaded type beam clamps shall have horizontally adjustable clamping bolt (or rod with nuts).

F. Concrete Anchors: Wedge type expansion anchors, with hex nut and washer, and stainless steel split expansion rings. Tested to ASTM E 488 criteria, UL listed, with exposed anchor head stamped with code to identify anchor length.

G. General Anchors (Screws, Nuts, Bolts, Fasteners):
1. General: Constructed of materials suitable for the conditions exposed to and materials being joined, with minimum 50 year service life. Stainless steel construction where exposed to corrosive conditions. Configuration, size and grade to suit application, accommodate expected forces, and provide anchoring to structural element (or allow for proper fastening of items). Minimum safety factor of 2.5 (or as required by code, whichever is greater). Comply with ASTM A307, SAE J429, SAE J78, or ASTM A 563; bolts and nuts shall have unified inch screw threads (course, UNC).
2. Test Reports: Provide independent test report indicating fastener strength (pullout and shear) as installed in the materials and applications of this project (when required by the Engineer or AHJ).
3. Finish: In finished areas, the portion of fastener exposed to view shall match the exposed finish of item being fastened.

H. Manufactured Strut Systems:
   1. Channels: Minimum 12 gauge, 1-5/8 x 1-5/8" (unless noted otherwise), with slots/holes to suit application.
   2. Accessories: Channel nuts press formed, machined and hardened with gripping slot, fabricated from steel conforming to ASTM A 108 or ASTM A 36. Fittings fabricated from steel in accordance with ASTM A 907.
   3. End Caps: Vinyl cap, capable of withstanding high temperatures without degradation, manufactured specifically for use with manufactured strut. Unistrut Series P2859 or P2860 (or approved).

I. Steel: Structural steel per ASTM A 36.

J. Wood: Only allowed to be used where building structural elements are of wood construction same type, grade used for building structural members. Where located outdoors shall be the pressure treated type; with all cut portions of wood painted with wood preservative.

K. Field Galvanizing Compound: Brush or spray applied galvanizing treatment; consisting of a premixed ready to apply liquid organic zinc compound, with 95% metallic zinc content by weight in dry film. ZRC worldwide “ZRC Cold Galvanizing Compound”.

2.3 PIPE HANGERS AND SUPPORTS

A. Copper Pipe: All hangers used directly on copper pipe shall be copper plated or have a factory applied 1/16-inch thick (minimum) plastic coating on all contact surfaces.

B. Cushion Clamps: Pipe clamps with a vibration dampening insert between the pipe and clamp, with a nylon inserted lock-nut on clamp. Insert shall be constructed of a thermoplastic elastomer, designed to tightly fit and match pipe size and clamp used with; suitable for system temperatures.

C. Type: Shall be MSS type selected in accordance with MSS-69; except that MSS type 24, 26, and 34 shall not be used.

2.4 DUCT HANGERS AND SUPPORTS

A. Hangers: As shown in SMACNA-DCS except that wire shall not be used and all materials used shall comply with these specifications.

B. Vertical Duct Supports at Floor: 1-1/2" x 1-1/2" x 1/8" (minimum) galvanized steel angle and to support ducts, maximum 12 foot on center, and as shown in SMACNA-DCS. For ducts over 30 inches wide provide riser reinforcing with hanger rods between the riser support and riser reinforcing.

C. Vertical Duct Supports at Wall: 1-1/2" x 1/8" (minimum) strap or 1-1/2" x 1-1/2" x 1/8" (minimum) angle bracket and as shown in SMACNA-DCS.

D. Hanger Attachments to Structure: As shown in SMACNA-DCS to suit building construction and as allowed on structural drawings. Provide washers at all fasteners through hanger straps (regardless of SMACNA-DCS allowances). Where C-clamps are provided, retainer clips shall be used. Friction beam clamps shall not be used.

E. Hanger Attachments to Ducts: As shown in SMACNA-DCS except that wire shall not be used as any form of support or attachment for ducts.

F. Flexible Duct Strap: Woven polypropylene hanging strap, minimum tensile strength of 400 lbs, minimum 1.75-inches wide, designed and intended for flexible duct support.

G. HVAC Support Wire: Steel, minimum 12 gauge, soft-annealed wire, complying with Federal Specification QQ-W-461H, and IBC for support of ceilings and accessories installed in ceilings.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. General: Provide all necessary bolts, nuts, washers, fasteners, turnbuckles, hanger rods, rod connectors, stanchions, wall/roof/floor backing and attachments, bridging between structural members, and any other miscellaneous accessories required for the support and anchoring of all pipes, ducts, and mechanical equipment. All supports, whether from floor, walls, or hung from structure, are Contractor's responsibility. Anchors and supports shall be adequate to accommodate forces equipment will be exposed to. Any field cut pieces of galvanized materials shall be hot-dip galvanized after cutting; or be solvent and wire brushed clean and receive field applied galvanizing treatment. This field applied galvanizing (only allowed with prior permission for minor localized cuts) shall use multiple coats to provide as near equal protection as possible to factory (or hot-dip) applied coatings.

B. Backing: Install steel or wood backing in walls (anchored to studs) and in ceiling (anchored to joists or trusses), as required to provide support for items.

C. Installation: Install all inserts, anchors, and supports in accordance with manufacturer's instructions, code requirements, and best professional practices. The most restrictive criteria governs.

D. Welded Assembly Finish: All welded steel support assemblies shall have a power wire brush and primer paint finish where installed indoors and be have factory applied hot-dip galvanized finish where installed outdoors (or subject to moisture); unless another finish is specified.

E. Attachments: Attach to anchoring element (i.e. building structure, concrete pads, etc.) as shown on drawings (reference structural drawings). Where not detailed on the drawings, the Contractor shall design and submit shop drawings of proposed attachment methods to the Engineer for review.

F. Application:
1. Where not detailed on the drawings (or otherwise indicated), the selection and design of supports is the Contractor’s responsibility, in compliance with code and Contract Document requirements; subject to submittal review and acceptance by the Engineer.
2. Exposed supports in finished areas shall be arranged to minimize their visibility; be free of dents, scratches and labels, and be configured in a manner to match the decorum and finish of the room they are installed in. Exposed supports in finished areas shall be cleaned to allow for field painting (unless a chrome, stainless steel, or similar finish has been indicated).
3. HVAC Support wire and flexible duct strap shall only be used for support of ceiling air inlets and outlets, or at flexible duct supports.

G. Manufactured Strut (“Unistrut”): Provide end caps on all strut ends at the following locations:
1. Where exposed to view in finished areas.
2. Where near maintenance access paths.
3. Where personnel injury could occur if the ends were not covered.

H. Seismic: Provide hangers, supports, anchors and bracing as required by code and as necessary to accommodate forces in a seismic event. Seismic bracing is not required for piping sized 2-inch and less, or for horizontal piping where the distance from the top of the pipe to the support attachment point to the building structure is less than 12-inches (unless noted otherwise). Seismic bracing is not required for ductwork less than 28-inch in diameter or having across sectional area less than 6 square feet, or for horizontal ductwork where the distance from the top of the duct to the support

attachment point to the building structure is less than 12-inches (unless noted otherwise). All equipment shall be seismically anchored.

3.2 INSTALLATION OF PIPE HANGERS AND SUPPORTS

A. General: Aboveground pipe shall be anchored to the structure to prevent sagging, to keep pipe in alignment, and to resist the forces the pipe will be exposed to; piping shall be supported independent of equipment so that no loads bear on the equipment.

B. Adjustment: All pipe supports shall be provided with a means of adjustment for the aligning and leveling of the pipe after installation.

C. Applications: Selection, sizing, and installation of pipe supports and accessories shall be in accordance with the manufacturers recommendations, standards MSS SP-89 and MSS SP-69, UPC, and IMC. Refrigerant piping and similar piping subject to vibration (i.e. high pressure tubing) shall be installed with cushion clamps.

D. Support Spacing: Provide piping support spacing according to the most restrictive of the following: UPC, IMC, ASME B31.1, B31.9, local codes, manufacturer's recommendations or Contract Documents specific requirements. Provide supports at each change in direction of piping and at each side of concentrated loads (such as in-line pumps, valves greater than size 5", and similar items).

E. Vertical Piping Supports: Support piping at each floor line with pipe clamps and at intermediate points as required so that hanger spacing does not exceed allowable spacing and as required to prevent excessive pipe movement and so as to comply with the maximum spacings cited above. Support all pipe stacks at their bases with a concrete pier or suitable support. For vertical pipe drops which occur away from a wall or similar anchoring surface, provide angled bracing from nearest structure on two sides of drop to provide rigid anchoring of pipe drop.

3.3 INSTALLATION OF DUCT HANGERS AND SUPPORTS

A. General: Provide anchors and supports for all ductwork. Supports and hangers shall comply with SMACNA-DCS, except that hanger spacing and hanger maximum loads shall be governed by whichever is more restrictive between these specifications or SMACNA-DCS.

B. Hanger Spacing -- Rectangular Duct:

Duct Area	Maximum Spacing
Up to 4 Square Feet	8 Feet
4.1 to 10 Square Feet	6 Feet
10 Square Feet and Up	4 Feet

C. Hanger Spacing -- Round Duct:

Duct Area	Maximum Spacing
Up to 24 Inch Diameter	8 Feet
25 Inch to 48 Inch Diameter	6 Feet
49 Inch Diameter and Up	4 Feet

D. Hanger Spacing - Flexible Duct: 4 feet, and at changes of direction as needed to maintain duct elevation and smooth airflow.

E. Vertical Ducts: Support at each floor level, but in no case less than on 12 foot intervals.

F. Flexible Duct: Support with methods shown in ADC. Metal strap in contact with the flexible duct shall have minimum 1.5-inch width.

G. Fittings: Provide supports at each change in direction of duct for ducts with 4 square foot area or more, or for ducts larger than 24 inch diameter. Locate hangers at inside and outside corners of elbows--or at each end of fitting on each side.

H. Concentrated Loads: Provide additional supports at each side concentrated loads such as modulating dampers (24" x 24" and larger), duct heaters (18" x 18" and larger), sound attenuators (all sizes), and similar items.

I. Exterior Duct: Provide supports for exterior ductwork as shown in SMACNA-DCS; spacing as specified herein.

J. End of Duct: At end of duct run, hangar shall be located no more than 1/2 the allowed hangar spacing from the end of the run.

3.4 CEILING SERVICES

A. Less than 20 Pounds: Ceiling mounted services, air inlets/outlets, and accessories weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners (or ceiling support members) or to cross runners with the same carrying capacity as the main runners (or support members).

B. 20 to 56 Pounds: Ceiling mounted services, air inlets/outlets, and accessories weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge wire hangers (or minimum 1” x 22 gauge hangar straps) connected from the terminal or service to the ceiling system hangers or to the structure above. These added hangers may be slack.

C. Greater Than 56 Pounds: Ceiling mounted services, air inlets/outlets, and accessories weighing more than 56 pounds shall be supported directly from the building structure by approved hangers.

3.5 MECHANICAL EQUIPMENT ANCHORS AND SUPPORTS

A. General: Provide anchoring and supports for all mechanical equipment. All equipment shall be anchored to (or supported from) the building structure. In lieu of anchoring to the building, anchor outdoor equipment to the concrete pad serving the equipment.

B. Suspended Equipment: Support as indicated on the plans. Where not indicated use the methods shown (or consistent with) Mason SRG and SMACNA-DCS; submit shop drawings of the proposed methods to the Engineer for review.

C. Roof Mounted Equipment: Install on roof curbs or roof sleepers as indicated. Anchor equipment to the curb (or sleeper), with the curb (or sleeper) in turn anchored to the building structure.

D. Vibration Isolation: Equipment shall be supported and anchored in such a way so that no equipment vibration is transmitted to the building structure.

END OF SECTION 200529

SECTION 200530

SLEEVES AND SEALS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Pipe Sleeves.

B. Duct Closure Collars.

1.3 SUBMITTALS

A. General: Shall comply with Section 20 05 00.

B. Product Data: Provide product data on all material to be use. Provide MSDS for all sealants, caulks and similar materials.

C. Shop Drawings – General: Shop drawings of proposed sealing/flashing assembly for roof and exterior wall penetrations.

1.4 REFERENCES

A. ASTM A 36: Standard Specification for Carbon Structural Steel.

B. ASTM C534: Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

C. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.

D. ASTM E 814: Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

E. UL 1479: Standard for Fire Tests of Through-Penetration Firestops.

F. UL 723: Surface Burning Characteristics of Building Materials.

G. SMACNA-DCS: SMACNA HVAC Duct Construction Standards, 3rd Edition.

H. SMACNA-ARCH: SMACNA Architectural Sheet Metal Manual, 7th Edition.

1.5 GENERAL REQUIREMENTS

A. Corrosion Protection: All sleeves exposed to water, moisture, chemicals, or subject to corrosion shall be constructed of corrosion resistant materials suitable for the exposure. Steel sleeves shall be hot dip galvanized after assembly. Provide additional coatings as noted or as required to resist corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Sleeve Material: Selected by Contractor.

C. Firestop Seal Materials: 3M, Dow Corning.

D. Seal Materials: 3M, GE, Dow Corning, Tremco, Pecora, Sonneborn, Pipeline Seal & Insulator.

2.2 PIPE SLEEVES

A. Diameter:
1. Belowground: Inside diameter of belowground pipe sleeves shall be at least 2 inch larger than the outside diameter of the pipe or pipe covering (for covered piping systems), so as to allow free movement of piping.
2. Aboveground: Inside diameter of aboveground pipe sleeves shall be at least 1-inch larger than the outside diameter of the pipe or pipe covering (for covered piping systems), so as to allow free movement of piping.
3. Large Movement: Provide larger sleeves where a larger space around pipe exterior is required by code, where specifically noted, where pipe movement will occur (i.e. expansion/contraction or seismic), at expansive soils, other unusual conditions are present, and where required to accommodate large piping movement.

B. Length: Horizontal sleeves through finished areas (where sleeve is exposed to view) shall be sized to be flush with finished surfaces; other horizontal sleeves may terminate flush to 2-inches past the element being penetrated. Vertical sleeves shall be sized to extend one inch above the final floor elevation.

C. Structural Type: Fabricated from schedule 40 steel pipe. Waterstop shall consist of fully welded 2-inch larger diameter collar, minimum 1/4 inch thick steel, located on sleeve so as to be centered within the element being penetrated. Provide waterstop on sleeves where sleeves are installed in the following locations: in cast-in-place concrete, where any part of the sleeve ends are exposed to water, where installed in floors with water-proofing or water stopping membranes, in rooms with floor drains, and where needed for anchoring/support purposes. Prime paint all surfaces with rust-inhibiting paint.

D. Non-Structural Type:
1. General Type: Fabricated from 18 gauge galvanized sheet metal or 22 gauge spiral seam galvanized steel duct. Provide with galvanized steel angle tabs, collars, or similar to allow for anchoring where sleeve cannot be retained in place by element being penetrated.
2. Flexible Type: Flexible cellular elastomeric insulation, complying with ASTM C 534, Type 1, minimum 1/2-inch thick. Water vapor permeance shall not exceed 0.08 perms. Operating Temperature Limits -20 degrees F to 180 degrees F. Provide in sheet or pre-fabricated pipe size; provide multiple wraps as required.

2.3 DUCT CLOSURE COLLARS

A. General: Closure collars shall provide closure of opening between duct and opening in element penetrated and shall abut tight up to and overlap duct and shall consist of rolled angle material (for round ducts) and welded framed angles (for rectangular and round ducts).

B. Size: Closure collars shall be sized to match duct and opening applied to and shall have minimum 2-inch overlap on duct side and 2-inch overlap at opening/penetrated element side but shall

completely cover opening in element penetrated with minimum 1-inch overlap to undisturbed element (i.e. wall, floor, etc.).

C. Material: Closure collars shall be fabricated of 20 gauge galvanized steel for ducts 15 inches diameter and less and shall be fabricated of 18 gauge galvanized steel duct for all larger ducts and all square and rectangular ducts.

2.4 NON-FIRESTOP SEALS

A. Indoor Sealants:

1. Smoke or Sound Sealant Applications: For use where a firestop seal is not required, but smoke or sound seal is required. Single component, elastomeric or acrylic latex type sealant with STC ratings per ASTM E90. Sealants shall be of the following types, or approved equal:
   a. 3M “Smoke and Sound Sealant SS100”.
   b. Tremco “Tremstop”.
2. Other Areas - Dry (Not Normally Exposed to Water/Moisture): Single component, latex sealant complying with requirements of ASTM C834. Sealants shall be of the following types, or approved equal:
   a. Tremco Corporation “Tremflex 834”.
   b. Pecora Corporation “AC-20 Arylic Latex”.
   c. Sonneborn Building Products “Sonolac”.
3. Other Areas - Wet (Exposed to Water/Moisture): Single component, mildew resistant silicone sealant complying with requirements of ASTM C920, Type S, Grade NS, Class 25. Color white. Sealants shall be of the following types, or approved equal:
   a. Dow Corning “786 Mildew Resistant Silicone”.
   b. Pecora Corporation “898 Silicone Sanitary Sealant”.
   c. Tremco “Tremsil 200”.

B. Outdoor Sealants:

1. General: Single component, non-sag, low modulus, silicone elastomeric sealant conforming to requirements of ASTM C920, Type S, Grade NS, Class 100/50. Sealant shall be of the following types, or approved equal.
   a. Dow Corning “790 Silicone Building Sealant”.
   b. Pecora Corporation “890 Silicone”.
   c. Tremco “Spectrem 1”.
2. Adjacent to Aluminum: Single component, non-sag, medium modulus, silicone elastomeric sealant conforming to requirements of ASTM C920, Type S, Grade NS, Class 50. Sealant shall be primer-less type for use in joints adjacent to fluoropolymer coatings. Sealants shall be of the following types, or approved equal:
   a. Dow Corning “795 Silicone Building Sealant”.
   b. GE Silicones, Momentive, SCS2000 and SCS7000.
   c. Pecora “895 Silicone”.
   d. Tremco “Spectrem 2”.

C. Expanding Foam Sealant:

1. General: Single component, polyurethane insulating sealant with flame spread index of 25 or less and smoke development rating of 50 or less. Shall expand and fully cure within 24 hours to a semi-rigid, closed cell, water and air resistant foam. Sealant shall be of the following types, or approved equal.
   a. DAP “Kwik Foam”.
   b. Fomo Products “Handi-Foam”.
   c. Todol Products “EZ Flo Gun Foam”.

D. Full Water Immersion Sealant: Polysulfide or Polyurethane; ASTM C920, M or Type S, Grade NS, Class 25, uses M and A; approved by manufacturer for “continuous water immersion”, single or multi-component.
   1. Tremco “Vulkem 116”.
   2. Sonneborn “Sonalastic Polysulphide Sealant”.

E. Specialty: Packed fiberglass or wool insulation; with silicone sealant rated for use with temperatures and other conditions encountered.

F. Grout: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout. Nonshrink; recommended for interior and exterior applications. Design mix shall provide 5000-psi, 28-day compressive strength. Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPE SLEEVES

A. General: Provide sleeves for all piping passing through walls, floors, partitions, roofs, foundations, footings, grade beams, and similar elements. Except that sleeves are not required at core drilled penetrations through solid concrete or where formed openings equivalent to a core drilled opening are provided. Sleeves shall be the following type (horizontal/vertical refer to position of sleeve):
   1. Horizontal, Aboveground:
      a. Concrete and Masonry Walls: Structural type.
      b. Other Walls: Non-structural type.
   2. Vertical, Slab on Grade: Structural type; except at piping serving individual fixtures or individual heating units in finished areas, the flexible type may be used. Where not installed to be concealed (as in a plumbing chase) install height of flexible type so it is concealed by the floor finish, cabinet base, or an escutcheon.

B. Installation: Set sleeves plumb or level (or sloped as required for sloped pipes) in proper position, tightly fitted into the work. Set sleeves properly in element for specified projection past adjacent surfaces (see sleeve product specification); cut ends of sleeve as necessary.

C. Insulation: Insulation shall run continuous through sleeves (unless noted otherwise).

3.2 DUCT CLOSURE COLLARS

A. General: Closure collars shall be provided for all exposed ducts and at all duct penetrations into mechanical (attic) rooms (on both sides of the penetration).

B. Installation: Collar shall be installed tight against surfaces and shall fit snugly around the duct or duct covering. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier of insulated ducts. Collars shall be anchored to element penetrated, with fasteners appropriate to material fastening to, on maximum 6 inch centers.

3.3 SEALS

A. General: Provide seals around all ducts, conduit, and piping passing through sleeves, walls, floors, roofs, foundations, footings, partitions, and similar elements. Seals shall be watertight where the penetration may be exposed to water or moisture. Provide type of sealant to suit the application. Provide smoke and sound type at all penetrations of rooms which contain mechanical equipment on both side of element penetrated to a depth of 5/8-inch (unless noted otherwise).

B. At Sleeves:

1. Between Sleeve and Penetrated Element: Fill openings around outside of pipe sleeve with same material as surrounding construction, or with material of equivalent fire and smoke rating and properties that allow a tight seal between the sleeve and the surrounding construction. Seal full depth of sleeve for vertical penetrations.
2. Between Pipe and Inside of Sleeve: Provide sealant between outside of pipe or pipe covering (for covered piping systems) and inside of sleeve. Seal depth shall be minimum 1-inch each side.

C. Preparation: Remove loose materials and foreign matter impairing adhesion of seal. Perform preparation in accordance with recognized standards and sealant manufacturer's recommendations. Protect elements surrounding area of work from damage or disfiguration due.

D. Installation: Install sealants immediately after joint preparation. Install sealants free of air pockets, foreign embedded matter, ridges, and sags. Tool exposed joint surface concave and with a neat finished appearance.

END OF SECTION 200530

SECTION 200548

VIBRATION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Vibration Isolation.

1.3 DEFINITIONS

A. "Equipment" is defined to mean any item with power connections (fans, HV units, AHU units, etc.), and also to include all hoods; but does not include pumps less than 3 hp.

B. "Equipment Requiring Vibration Isolation" is defined to be any equipment (as defined above) with rotating components (e.g. pumps, fans, etc.).

1.4 SUBMITTALS

A. General: Submittals shall comply with Section 20 05 00.

B. Product Data:
1. Submit product data on all items to be used.
2. Submit calculations showing vibration isolation selection for all isolation devices provided under this specification section (i.e. where isolation is not furnished integral with the equipment or by the manufacturer of the equipment).

C. Shop Drawings: Submit shop drawings for all fabricated support assemblies.

1.5 GENERAL REQUIREMENTS - VIBRATION ISOLATION

A. General:
1. Select and provide all vibration isolation devices for all equipment requiring vibration isolation so as to provide complete installed mechanical systems free of the transmission of vibration and vibration generated noise to the structure.
2. Vibration isolation is shown on the drawings for various items but is not shown for all items requiring isolation. Provide all isolation as indicated and specified herein.

B. Supplier: Where not provided by the equipment manufacturer, all vibration isolation devices and support assemblies shall be supplied as a coordinated package by a single vibration isolation manufacturer, under this specification section.

C. Equipment Manufacturer Items: Isolation devices furnished by equipment manufacturer shall comply with this specification section and be selected by the manufacturer to suit, and provide satisfactory performance, for the applications of this project.

1.6 REFERENCES

A. IBC: International Building Code.

B. IMC: International Mechanical Code.

C. UPC: Uniform Plumbing Code.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Products: Mason, Peabody, Kinetics Noise Control, Vibration Eliminators, VMC Group.

C. Expansion Devices/Flexible Connectors: Unisource Manufacturing, Twin City Hose, and as specified in Section 20 05 19, and 23 33 00.

2.2 NEOPRENE ISOLATORS

A. Isolation Pads: Oil resistant bridge bearing neoprene pads, minimum 3/4-inch thick, with cross-ribbed or waffle design. Size pads for not more than 50 psi or as recommended by vibration isolator manufacturer. Provide load distribution plates (minimum 3/8" plate steel) to evenly load pads. Mason Type SW (or approved).

B. Floor Mounted Isolators: Double deflection neoprene mounts, sized for minimum deflection of 0.30-inch. All metal surfaces shall be neoprene covered, base plate shall have mounting holes, and top shall have threaded steel plate or threaded steel insert. Element shall be color coded or labeled with molded symbols to identify capacity. Neoprene shall be bridge bearing type. Mason Series ND (or approved).

C. Suspension Isolators: Double deflection neoprene type, with isolator encased in open steel bracket, and sized for minimum 0.30-inch deflection. Hanger rod shall be isolated from steel bracket with neoprene grommets. Mason Series HD (or approved).

D. Washer Bushings: Bridge bearing neoprene washer insert to provide isolation between anchor bolt and washer from support member/equipment. Mason Series HG (or approved).

2.3 SPRING ISOLATORS

A. General: The load carried by each isolator shall be carefully calculated and isolators selected so that the static deflection will be the same and the supported equipment will remain level. Isolators shall be so designed that the ends of the springs will remain parallel during and after deflection to operating height. At operating height, springs shall have additional travel to complete (solid) compression equal to at least 50 percent of the operating deflection. Suspension isolator springs shall have a static deflection not less than 1-inch (unless noted otherwise), except that for units with components rotating at 1000 rpm and less, the static deflection shall be not less than 2-inches (unless noted otherwise). Floor isolator springs shall have deflection of not less than 1-inch. All isolators shall provide at least 95% isolation efficiency. Deflections other than these may be used where circumstances warrant and more optimum isolation results can be achieved; provided that a written explanation is submitted for Engineer review and approval.

B. Floor Housed Type:
   1. Ductile Iron: Housed spring isolator with ductile iron housing, base plate with mounting holes, spring inspection ports, neoprene cushion, adjustable upward rebound plate. OSHPD

pre-approved. Provide with mounting brackets to suit equipment connected to. Mason Series SSLFH (or approved).

2. Welded Steel: Housed spring isolator with welded steel housing, steel base plate with mounting holes, number of springs to suit application, neoprene vertical limit stops, spring bottom neoprene acoustical cups, bottom non-skid neoprene friction pad, and equipment attachment configuration to suit equipment served. OSHPD pre-approved. Provide with mounting brackets to suit equipment connected to. Mason Series SLR or SLRSO (or approved).

C. Suspension Type Spring Isolators: Shall consist of a rigid steel frame with a stable steel spring in the bottom part of the frame, and double deflection neoprene (or rubber) isolating pad at the top of the frame. Where supporting rods pass through the frame, a clearance of not less than one-half rod diameter shall be provided all around the rod and neoprene bushings provided to prevent steel to steel contact. Mason Series DNHS or Series 30N (or approved).

PART 3 - EXECUTION

3.1 VIBRATION ISOLATION

A. General: Provide vibration isolators for all rotating equipment so that no vibration is transmitted to the structure. Isolators shall be the type indicated; except where not shown, type shall be as selected by vibration isolation manufacturer (or equipment manufacturer) to provide adequate isolation.

B. Installation: Install all vibration isolators in accordance with isolator manufacturer's instructions and isolated equipment manufacturer's recommendations.

C. Inadequate Isolation: Should vibration isolators prove inadequate to prevent transmission of vibrations to the building structure or limit equipment vibration generated noise, such isolators shall be replaced with isolators having the largest deflection that can be practically installed or otherwise modified/replaced to produce satisfactory isolation. Such replacement shall be at no additional cost to the Owner.

D. Equipment with Rotating Components not Requiring Isolation:
1. Wall mounted indoor heat pumps, ceiling cassette indoor heat pumps.
2. Air Handling units with internal isolation.
3. Grade-mounted condensing units.

3.2 TEST AND INSPECTION

A. Field Inspections: Prior to initial operation, the vibration isolators shall be inspected for conformance to drawings, specifications, and manufacturer's data and instructions. Check all flexible connectors/expansion devices for proper location, guiding, and end anchoring.

B. Vibration Isolator Inspection: After installation of isolators, remove all shipping blocks and other items that may prevent proper isolator operation. Inspect isolators to verify that the machinery moves freely on its spring isolators within limits of stops or seismic restraint devices. Eliminate or correct interferences.

C. Tests: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels. Re-balance, adjust, or replace machinery with noise or vibration levels in excess of those given in the machinery specifications or machinery manufacturer's data. Check for proper operation of expansion devices and associated items during system warm-up.

END OF SECTION 200548

SECTION 200593

TESTING, ADJUSTING, BALANCING FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Air Balancing.

B. Report.

1.3 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Company: Submit name of Company proposed to do the balancing and sample balancing forms. Where the Company has not been pre-qualified, and substitutions are allowed after bidding (see Division 00 and 01), submit information regarding firm qualifications.

C. Personnel: Submit list of personnel that will be assigned to the project and their qualifications, and list of past projects.

D. Reports: Preliminary and final balancing reports.

1.4 REFERENCES

A. AABC-NS: Associated Air Balance Council, National Standards for Field Measurements and Instrumentation.

B. ASHRAE: Handbook of Fundamentals.

C. ACGIH-IV: American Conference of Governmental Industrial Hygienists, Industrial Ventilation, A Manual of Recommended Practice.

D. NEEB-PS: National Environmental Balancing Bureau Procedural Standard for Testing, Adjusting and Balancing Environmental Systems.

1.5 GENERAL REQUIREMENTS

A. General: Balancing shall be done by a company which specializes in this type of work and is totally independent and separate from the Company which has installed the systems to be balanced.

B. Balancers Qualifications:
1. General: Work of this Section shall be performed by balancing firms meeting the following and having prior approval from the Engineer:

a. Professional Affiliation: Firm shall be an Associated Air Balance Council (AABC) member balancer or National Environmental Balancing Bureau (NEBB) certified balancer.
b. Experience: Firm shall have satisfactorily completed the balancing work for at least 5 similar projects in the last 3 years. Similar is defined to mean: within 10% of the same quantity of units and air inlets/outlets, involve same type of systems, be the same type of facility (i.e. school, hospital, etc.). The lead field balancer (i.e. the individual who will be on site directing and participating in the balancing efforts) shall have at least 5 years of experience performing balancing work on similar projects.
c. References: Have five references for similar projects which have been completed in the last three years that will give a good or better performance rating. References shall be engineers, architects, or building owners. As part of the qualification process at least three of these references will be contacted and a rating obtained for the following: timeliness of work (i.e. able to complete work on schedule), cooperative nature of balancer's staff (i.e. ability to work well as a team with other project trades and professionals), overall quality of balancing work, quality of balancing report. Each item will be rated on a scale of 1 to 5 (5 being excellent), with the result averaged, score must be of 4 or better.

C. Balancing Issues: Notify the Engineer in writing of all problems or discrepancies between actual conditions and what design documents show as work proceeds.

D. Engineer's Authority: The Balancer shall be directly responsible to the Engineer and shall perform this work and make system adjustments as directed by the Engineer.

E. Lead Balancer: The Balancer shall assign an individual as "lead balancer" to work in the field to directly supervise the balancing work and field technicians. This lead field balancer shall have at least 5 years of experience performing balancing work on similar projects.

F. Added Site Visits:
1. Trade Coordination Purposes: The Balancer shall include in his bid three extra site visits (beyond those otherwise included) and associated added time to assess system readiness for balancing, resolve system issues, coordinate balancing work, and perform other activities related to balancing and commissioning.
2. Engineer Directed: Include in bid two added site visits and 4 hours of field balancing work (each visit), plus report amendment time, to provide added balancing as directed by the Engineer. Such work may occur during the project's construction period or during the warranty period and is solely at the Engineer's discretion.

PART 2 - PRODUCTS

2.1 GENERAL INSTRUMENTATION

A. General: Balancing equipment shall comply with Associated Air Balance Council recommendations for field measurement instrumentation.

B. Calibration: All measuring instruments shall be accurately calibrated and maintained in good working order. Calibration dates and certifications shall be available at Engineer's request.

C. Instruments: Shall be capable of:
1. Air velocity instruments, direct reading in feet per minute with 2% accuracy.
2. Static pressure instruments, direct reading in inches water gauge with 2% accuracy.
3. Tachometers, direct reading in revolutions per minute with 1/2% accuracy; or revolution counter accurate with 2 counts per 1,000.
4. Thermometers, direct reading in degrees Fahrenheit with 1/10 of a degree accuracy.
5. Pressure gauges, direct reading in feet of water or psig with 1/2% accuracy.

6. Water flow instruments, direct reading in feet of water or psig with 1/2% accuracy suitable for readout of balancing valve provided.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship: All measurements and adjustments shall be in accordance with AABC-NS, NEEB-PS, and ACGIH-IV and recognized best balancing procedures. Measurements and adjustments of equipment shall be executed in a manner consistent with the manufacturer's recommendations.

B. Flow Rates:
1. General: All air and water systems shall be completely balanced and adjusted to provide the flow rates indicated (within tolerances indicated in this specification Section), and to produce an even heating and cooling effect and control response.
2. Balancer Determined: Where flow rates have not been indicated the balancer shall determine such flow rates using acceptable practices in accordance with AABC-NS, NEEB-PS, and ASHRAE standards and submit the proposed flow rates to the Engineer for review.
3. Confirmation: Prior to beginning balancing confirm any flow rate changes since design with the submittals and flow rates indicated therein, and with the Engineer to confirm changes made since design. Assume that new flow rates will be issued.

C. Controls: Consult and coordinate with the Control Contractor for the adjustment and setting of all control devices to allow for the balancing work, and for proper system operation and proper flow rates. Set all controls and valves as required to maintain design flow rates and temperatures as shown on the drawings. Make measurements and provide data to the Control Contractor to allow for proper control of items.

D. Comfort Adjustments: Make final adjustments for flow rates in order to optimize each space's comfort, including such considerations as temperature, drafts, noise, pressurization, and air changes. Where variances are made from design values, state reasons in report (e.g., "too noisy", "too drafty," etc.). All such variances are subject to approval by the Architect/Engineer.

E. Deficiency Reports: Submit deficiency reports where the work does not allow balancing to occur or balancing issues develop. Indicate date, system and equipment involved, location, description of deficiency, and related information to allow for diagnosing the problem. Provide suggestions for resolution where possible.

3.2 AIR BALANCING

A. Pre-check of System: Prior to beginning balancing, perform, as a minimum, the following:
1. Verify that clean filters have been installed, that system is free from debris, and that all inlets/outlets are not obstructed.
2. Check all fans and equipment to verify that proper start-up and system preparation has been done by the installing contractor.
3. Check all door/window and similar building opening status to insure building is ready and proper pressurization can be obtained.
4. Open all dampers to full flow position, check positions and operation of all motorized dampers to allow full system flows.
5. Review controls and sequences of operation.

B. Tolerances: All air flow rates (supply, return, and exhaust) shall be adjusted to within plus 5 percent and minus 5 percent of the values shown in the contract documents, except that relative space-to-space pressure relationships shall always be maintained (e.g., restrooms shall be negative relative to other areas, general offices shall be positive, etc.).

C. Draft and Noise Adjustments: All diffusers, grilles, and registers shall be adjusted to minimize drafts and to eliminate objectionable noise.

D. Filters: Air balancing shall be done with new, clean air filters installed. Adjust air deliveries so that design quantities will be obtained when filters are half dirty. This condition shall be simulated by covering a portion of the filter area.

E. Fan Speeds and Drives:
   1. Adjust fan speeds and fan drives (adjustable sheaves) as required to produce design flow rates.
   2. Where new sheaves are required, calculate sizing of new sheave and coordinate requirements with the Division 23 Contractor; Division 23 Contractor to furnish new sheaves. Replace existing sheave with new one furnished by the Division 23 Contractor; include bid costs for sheave replacements on all belt driven fans.
   3. Adjust belts for proper tension.

F. Marking: Upon completion of flow readings and adjustments permanently mark the balanced position of all balancing valves by stamping the indicator plate of the valve.

G. Duct Traverse: Rectangular duct traverses shall measure the center of equal areas in the air flow stream, with centers not more than 6 inches apart. Round duct traverses shall measure at least 20 locations, with locations being the centers of equal annular area. Reference ACGIH Industrial Ventilation Manual.

H. One Open Run: Balance each branch run so that there is at least one wide open run; balance branches relative to one another so that at least one branch damper is wide open (except that where unique conditions exist, and the Engineer gives prior approval, one open damper on runs or branches is not required).

I. Data: Data to be measured/recorded and provided in report for all air handling systems and equipment:
   1. 1Floor plans clearly showing and identifying all diffusers, grilles, OA louvers, ducts and all other items where air flow rates were measured.
   2. 2Identify manufacturer, model number, size, and type of all air inlets/outlets.
   3. Initial, trial, and final air flow measurements for all diffusers, grilles, OA louvers, ducts, and all other items where air flow rates were measured.
   4. Design air flow rates and percentage final air flow rates are of design values.
   5. Final damper (or other balance device) final position (as a percentage of full open).
   6. The connected voltage and corresponding nameplate full load amps, and the initial and final amperages of all fan motors.
   7. Initial and final RPMs of all fans.
   8. Static pressures on inlet and outlet of all fans.
   9. Fan initial and final CFMs.
   10. Outdoor air CFMs (record minimum and maximum values).
   11. Entering and leaving air temperatures across coils with coils operating at 100% capacity.
   12. Static pressure drop across each filter bank and coil.
   13. Final position of any speed controls (as percent of full).
   14. In addition to data noted elsewhere, provide the following for all equipment which are part of balanced systems:
      a. Equipment name and number (as used on drawings).
      b. Service.
      c. Equipment manufacturer and model number.
      d. Sheave and belt sizes (where applicable).
      e. Filters sizes and quantities (where applicable).
      f. Motor manufacturer and complete nameplate data.
      g. Design operating conditions.

h. Actual operating conditions (flows, pressure drops, rpm, etc.).

J. Main Duct Airflows: Air flow measurements in main ducts shall be made with a duct traverse using a pitot tube and micromanometer. Summation of air terminal outlets and inlets is not sufficient. Quantity of duct leakage (difference between main duct airflow and sum of air inlets/outlets) shall be indicated.

3.3 HYDRONIC BALANCING

A. Pre-check of System: Prior to beginning balancing, perform, as a minimum, the following:
1. Verify that all strainers have been cleaned.
2. Examine fluid in system to verify system treatment and cleaning.
3. Check for proper rotation and operation of all pumps.
4. Verify that expansion tanks are not air bound and properly charged and that system is full of fluid.
5. Verify that all air vents at high points in the fluid system are properly installed and are operating freely. Verify that all air has been removed from the circulating system.
6. Open all valves to full flow position, close any bypass valves, and open fully balancing valves. Set temperature controls so that automatic valves are open to full flow.
7. Check operation of automatic bypass valves and similar flow/pressure controls.
8. Check and set operating temperature of equipment to design requirements when balancing by temperature drop.
9. Check equipment for proper start-up and system preparation by installing contractor.
10. Review controls and sequences of operation.

B. Tolerances: All water flow rates shall be adjusted to within plus 5 percent and minus 5 percent of the values shown in the contract documents.

C. Control Valve Bypass: Adjust control valve bypass valves so that pressure drop is the same for full flow-through bypass valve as for full flow-through control valve and controlled equipment.

D. Marking: Upon completion of flow readings and adjustments permanently mark the balanced position of all balancing valves by stamping the indicator plate of the valve.

E. Requirements for All Hydronic Systems: Data to be measured/recorded and provided in report:
1. Floor plans or schematics showing and identifying all valves, coils, pumps and other items where temperatures, pressure drops, or water flow rates were measured.
2. Identify manufacturer, model number, size and type for all balancing devices.
3. Initial, trial, and final water flow measurements (pressure drops, temperatures, and GPMs) for all items where measurements were made.
4. Design water flow rates, and percentage final water flows are of design values.
5. The connected voltage and corresponding nameplate full load amps, and the initial and final amperages of all pump motors.
6. Pump operating suction and discharge pressures and final total developed head.
7. Pump initial and final GPMs.
8. Entering and leaving fluid temperatures at coils and major equipment.
9. GPM flow of each coil and major equipment.
10. Pressure drop across each coil and major equipment.
11. Pressure drop across bypass valve.
12. Final position of all valves (percent open or setting position on valve).
13. Final position of any speed controls (as percent of full).
14. In addition to data noted elsewhere, provide the following for all equipment which are part of balanced systems:
    a. Equipment name and number (as used on drawings).
    b. Service.
    c. Equipment manufacturers and model number.

d. Equipment capacities.
e. Motor manufacturer and complete nameplate data.
f. Design operating conditions.
g. Actual operating conditions (flows, pressure drops, etc.).

3.4 BALANCING REPORT

A. General: A balancing report shall be submitted as specified herein, documenting all balancing procedures and measurements.

B. Report Organization: The report shall be divided into logical sections consistent with the building or system layout (i.e. by floors, building wings, air handling units, or other convenient way). Tabulate data separately for each system. Describe balancing method used for each system.

C. Preliminary Report: Two preliminary review copies of the balancing report shall be submitted to the Architect/Engineer when the balancing work is 90% complete (or as near 90% complete as possible due to uncompleted work of other trades). In addition to containing all the information required of the final report, the preliminary report shall contain a list of all the work required of other trades in order to allow the balancing work to be completed. The Architect/Engineer will review the preliminary report and inform the Contractor of any additional items or revisions required for the final report. Preliminary reports may be omitted where the Architect/Engineer grants approval.

D. Final Report: Shall be included in the Operation and Maintenance Manual. Submit reports to Contractor for inclusion in Manuals (or, when manuals have been already sent to Engineer, send report to Engineer who will insert report into Manual). Provide number of reports as required to match quantity of O&M Manuals, but in no case less than five.

E. Format: 8-1/2" x 11" size, neat, clean copies, drawings accordion folded. Report shall be typed, shall have a title page, table of contents, and divider sheets with identification tabs between sections. Information shall be placed in a three hole notebook, with the front cover labeled with the name of the Job, Owner, Architect/Engineer, Balancing Contractor, and Report Date.

F. Electronic Copy: Provide copy of reports in *.pdf format; submit final report with closeout documents per Divisions 00 and 01.

G. General Balancing Information Required:
1. At the beginning of the report, include a summary of problems encountered, deviations from design, remaining problems, recommendations, and comments.
2. List of instruments used in making the measurements and instrument calibration data.
3. Names of personnel performing measurements.
4. Explanation of procedures used in making measurements and balancing each system.
5. List of all correction factors used for all diffusers, grilles, valves, venturi meters, and any other correction factors used.
6. Areas where difficulties were encountered in obtaining design flow rates, or where unstable operating conditions may exist.
7. Note any parts of the system where objectionable drafts or noises may be present and efforts made to eliminate same and why they may still be present.
8. Note where variances from design values occur; explain why.
9. All specified measurements, balancing data, any additional recorded data, and observations.

END OF SECTION 200593

SECTION 200700

MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Duct Insulation.

B. Pipe Insulation.

1.3 DEFINITIONS

A. R: Thermal resistance of insulation, in units of hr-sf-deg F/Btu.

B. Subject to Damage: Items installed exposed less than 8 feet above the walking surface (i.e. floor, platform, roof, grade, etc.) adjacent to the item.

C. Cold Surfaces: Surfaces that will have operating temperatures below the temperature of the surrounding air by at least 5 deg F or more; includes chilled water piping, cooling condensate piping, air conditioning ductwork, outdoor air ductwork, and similar systems. Surfaces shall be considered a cold surface unless specifically indicated otherwise.

1.4 QUALITY ASSURANCE

A. All insulation and materials shall have a fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E 84, NFPA 255, and UL 723.

1.5 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Product Data: Provide product data on all insulation materials to be used. Indicate thicknesses to be used.

1.6 GENERAL REQUIREMENTS

A. Code Compliance: Contractor shall insulate all systems with the materials and thicknesses as required by code, but in no case shall the insulation be less than that specified herein. In some cases the specified insulation exceeds code, and shall be provided as specified. Not all systems requiring insulation by code are specified, but shall be provided with insulation where required by code.

B. Insulation at Hangers: Insulation shall be continuous through hangers on all insulated systems (except ductwork). Inserts at hangers are specified in Section 20 05 29 and are considered as part of the hanger and support system. Inserts are required to be installed at the time of pipe

installation and are intended to be installed by the Contractor installing the pipe hangers/supports. See Section 20 05 29.

1.7 REFERENCES

A. ASTM A 653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

B. ASTM B 209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM C 411: Standard Test method for Hot-Surface Performance of High Temperature Thermal Insulation.

D. ASTM C 547: Standard Specification for Mineral Fiber Pipe Insulation.

E. ASTM C 1136: Standard Specifications for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

F. ASTM C 1290: Standard Specification For Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

G. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.

H. NCIIS: National Commercial & Industrial Insulation Standards, published by Midwest Insulation Contractors Association, 5th Edition.

I. NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials.

J. UL 723: Tests for Surface Burning of Building Materials.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph Part 2.01, Acceptable Manufacturers.

B. Insulation: Johns Manville, Armacell, Owens-Corning, Knauf, Rubatex, Aeroflex, Pittsburgh Corning, GLT, Halstead, Gilsulate, Manson.

C. Accessories: Johns Manville, Armacell, Owens-Corning, Knauf, Rubatex, Aeroflex, Pittsburgh Corning, GLT, Halstead, Duro Dyne, Gustin Bacon, Childers, RPR, Tee Cee, Lewco Specialty Products, JPS, Buckaroos, Manson.

D. Acoustical Wrap: Kinetics Noise Control.

2.2 DUCT INSULATION

A. Type: Flexible blanket type, constructed of inorganic glass fibers bonded by a thermosetting resin, complying with ASTM C 1290, Type III. Johns Manville “Microlite” (or approved).

B. Jacket: FSK type, vapor proof, consisting of an aluminum foil cover reinforced with glass fiber mesh, and laminated to kraft. Water vapor permeance shall not exceed 0.05 perms. Provide with joint sealing tape, minimum 2 inches wide, constructed of jacket material with adhesive to seal all joints.

C. Thermal Conductivity: Shall not exceed 0.27 Btu-in/hr-sq ft-deg F at 75 deg F.

D. Operating Limits: 40 degrees F to 250 deg F.

E. Duct Insulation Thickness:
   1. General: Provide insulation densities and thicknesses to achieve the R values cited below. R values are for the insulation only, in their installed thickness, considering installed duct wrap stretch and in accordance with code.
   2. Lining: Where ducts have internal lining, the insulating properties of the lining may be credited toward meeting the required insulation R value; use R-3.65 per inch of installed liner.
   3. Supply Air Ductwork:
      a. Inside Building and Within Building's Thermal Envelope: R-3.3 (except where ran exposed in conditioned spaces, no insulation is required).
      b. Inside Building But Not Within Building's Thermal Envelope: R-7.3.
      c. Outside of Building: R-8.
   4. Return Air Ductwork:
      a. Inside Building and Within Building's Thermal Envelope: No insulation required; except where duct contains air that may vary by 10 deg F or more from the space the duct passes through, R-3.3 insulation shall be provided.
      b. Inside Building But Not Within Building's Thermal Envelope: R-7.3.
      c. Outside of Building: R-8.
   5. Outside Air Ductwork: Shall be insulated same as required for the building envelope; except where allowed by code to be insulated less than the building envelope, shall be R-8; insulation is not required where duct run outside the building.
   6. Exhaust, Relief, and Special Ductwork:
      a. Inside Building and Within Building's Thermal Envelope:
         1) Temperature of Air in Duct within 10 Deg F of Temperature of Air in Spaces Duct Passes Through: No insulation required except ductwork from the system's backdraft damper (or motorized damper) to outside the building shall be insulated same as required for the building envelope.
         2) Temperature of Air in Duct more than 10 Deg F Different from temperature of Air in Spaces Duct Passes Through: R-8.3; except ductwork from the system's backdraft damper (or motorized damper) to outside the building shall be insulated same as required for the building envelope (but no less than R-8.3).
      b. Inside Building But Not Within Building's Thermal Envelope: R-8.3.
      c. Outside of Building: Ducts carrying air where condensation can occur (i.e. air from dryers, locker rooms, kitchens, hoods, process loads, etc.) R-8.3; other ducts no insulation is required.

2.3 PIPE INSULATION

A. Glass Fiber:
   1. Type: Rigid molded type, constructed of glass fibers bonded by a thermosetting resin, complying with ASTM C 547 Type I. Insulation factory molded to match pipe size applied to. Johns Manville "Micro-Lok" (or approved).
   2. Jacket: ASJ type, vapor proof, consisting of a white kraft paper cover reinforced with glass fiber and bonded to aluminum foil, with longitudinal self sealing closure system. Provide with butt strips constructed of jacket material with adhesive to seal all joints. Water vapor permeance shall not exceed 0.02 perms.
   3. Thermal Conductivity: Shall not exceed 0.24 Btu-in/ hr-sq ft-deg F at 75 deg F.
   4. Operating Temperatures: 0 deg F to 850 deg F.

B. Elastomeric Insulation:
   1. Type: Flexible cellular elastomeric insulation, factory formed to match pipe sizes applied to, complying with ASTM C 534, Type 1. Aeroflex "Aerocell" (or approved).
   2. Thermal Conductivity: Shall not exceed 0.27 Btu-in/ hr-sq ft-deg F at 75 deg F.
   3. Water Vapor Transmission: Water vapor permeance shall not exceed 0.08 perms.

4. Operating Temperatures: -250 deg F to 300 deg F continuous without damage or deformation per ASTM C 411.
5. Weather Protection: Where installed outdoors provide with metal jacketing to protect from UV and weather exposure.

C. Pipe Fittings: Shall be covered using any one of the following methods of the Contractor's choice:
1. Prefabricated segments of pipe insulation of same materials and thickness as the adjoining pipe insulation, formed to match pipe fitting.
2. Pre-cut fiberglass insulation and pre-molded high impact, gloss white, UV resistant, minimum 20 mil thick, PVC covers suitable for the pipe size and insulation thickness application, PVC cover shall be Johns Manville "Zeston 2000 PVC" (or approved).
3. Insulating plastic cement brought up the full height of the adjacent covering.
4. Except, where colored PVC jacketing is applied to piping, fittings shall use PVC covers of the same thickness and color as the PVC jacketing specified for the piping.

D. Metal Jacket: Aluminum roll jacketing, factory formed to match pipe size and insulation application, with smooth surface, manufactured from 3003 or 5005 aluminum alloy, H-14 temper, conforming to ASTM B 209. Shall be minimum 0.020 inches thick, with an integrally bonded interior 1 mil thick heat bonded polyethylene moisture barrier over the entire surface in contact with the insulation. Fitting covers shall be fabricated of same material as pipe runs, factory formed to match fitting.

E. PVC Jacket: Pre-molded 30 mil thick PVC jacket; size and shape to match piping and fittings applied to. Johns Manville “Zeston Series 2000" (or approved). Provide in white color.

F. Pipe Insulation Types:
1. Aboveground-Inside Building:
   a. Cooling Coil Condensate: Glass fiber or elastomeric.
   b. Refrigerant Piping: Elastomeric.
   c. Other Systems: Glass fiber.
2. Aboveground-Outside Building: Same as specified above, with metal jacket.
3. Metal and PVC Jacketing: See “Part 3 - Execution”.

G. Pipe Insulation Thickness:
1. General: Provide minimum piping insulation thickness indicated, in inches.

INSULATION THICKNESS (INCHES)

Nominal Pipe Diameter (Inches)					
Fluid Design Operating Range, deg F	<1	1< to 1-1/2	>1-1/2 to <4	4 to <8	≥8
Above 350	4.5	5.0	5.0	5.0	5.0
251 - 350	3.0	4.0	4.5	4.5	4.5
201 - 250	2.5	2.5	2.5	3.0	3.0
141 - 200	1.5	1.5	2.0	2.0	2.0
61 - 140	1.0	1.0	1.5	1.5	1.5
40 - 60	0.5	0.5	1.0	1.0	1.0
Below 40	0.5	1.0	1.0	1.0	1.5

2. Varying Temperatures: Where a system operates over temperature ranges calling for different insulation thicknesses, the thicker insulation requirements shall be met.
3. Condensate: Cooling system condensate piping (i.e. from a cooling coil) shall be considered to operate at 50 deg F.
4. Refrigerant Piping: Refrigerant piping (RG or RS piping) returning from an evaporator (i.e. cooling coil) to a compressor shall be considered to operate at 40 deg F. Refrigerant piping (RL piping) from a condenser to an evaporator does not require insulation (unless noted otherwise).

5. Outdoor Piping: Piping exposed to outside air or, located outside the building/thermal envelope, shall have insulation thickness increased by 0.5 inch from that indicated above.

2.4 EQUIPMENT AND SPECIALTIES INSULATION

A. Corner Angles: 0.016 inch thick aluminum, alloy 3003 or 5005, with factory applied Kraft backing, complying with ASTM B 209.

B. Metal Jacket:
1. Steel: Minimum 24 gauge galvanized steel complying with ASTM A 653. Provide with longitudinal slip joints and 2-inch laps.
2. Aluminum: Minimum 0.020-inch thick aluminum, alloy 3003 or 5005, complying with ASTM B 209. Provide with longitudinal slip joints and 2-inch laps.

2.5 ACCESSORIES

A. Adhesive, Caulks, Mastics, and Coatings: As recommended by insulation material manufacturer and suited for the application.

B. Bands: 1/2-inch wide, of stainless steel, galvanized steel, or aluminum construction, to match with materials used with.

C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length shall be as required for insulation thickness used with. Welded pin holding capacity 100 lb, for direct pull perpendicular to the attached surface. Style and type to suit application.

D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness used with. Adhesive as recommended by the anchor pin manufacturer as appropriate for surface temperatures and materials used with, and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface. Style and type to suit application.

PART 3 - EXECUTION

3.1 GENERAL

A. Pre-Insulation Review: No covering materials shall be applied until systems to be covered have had all tests satisfactorily completed, have had all required inspections, and have been satisfactorily reviewed by the Architect/Engineer. All systems shall be examined by the Contractor to confirm cleanliness and other conditions are appropriate to allow for insulation installation.

B. Insulation Work Review: No insulated items shall be concealed in the building structure or buried until the insulation work has been satisfactorily reviewed by the Architect/Engineer, and has had all required inspections.

C. Standards: Materials shall be installed in accordance with manufacturer’s written instructions, NCIIS, and shall comply with materials and methods specified herein. The more stringent requirements govern.

D. Joints/Seams: Joints shall be staggered on multi layer insulation. Locate seams and joints in least visible location.

E. Insulation Protection: Insulation shall be kept clean and dry and shall be protected from dirt, damage, and moisture. Insulation that becomes dirty, damaged, or wet and cannot be restored to like new condition will be rejected, and shall immediately be removed from the jobsite.

F. Insulation Interruptions: Insulation shall be neatly finished at all supports, protrusions and interruptions. Provide adhesive and tape seal to maintain vapor barrier integrity.

G. Equipment and Floor Protection: Cover existing equipment and finished floors to protect such items from insulation fiber and dust. Keep all such existing areas in a "broom clean" condition at the end of each day. Take precautions in these areas to prevent glass fiber and insulation dust from entering ventilation systems or areas adjacent to the work.

H. Glass Fiber Insulation - General:
1. Finish all insulation ends with joint sealing tape or vapor barrier mastic, no raw edges allowed.
2. Joints: Tightly butt adjacent insulation sections together without any voids. Provide overlap of jacket material over all joints.

I. Items To Be Insulated: Provide insulation on all ductwork, all piping, all items installed in these duct and piping systems, all air and liquid energy conveying systems and components, all air and liquid energy storage, all equipment, and all energy consuming devices, except where such insulation has been specifically excluded.

J. Items Excluded From Being Insulated:
1. Electric motors.
2. Fans.
3. Factory insulated or factory lined HVAC, AHU, and AC units.

3.2 DUCT INSULATION INSTALLATION

A. Types and Thickness: Insulate all ducts with insulation type and thickness (to provide the required R value) as specified in “Part 2 - Products”.

B. General: Insulation shall be firmly butted at all joints. All longitudinal seams for flexible insulation shall overlap a minimum of 2 inches. All joints and seams shall be finished with appropriate joint sealing tape. Installation shall provide a continuous sealed vapor barrier over all surfaces; seal all jacket penetrations with vapor barrier mastic or vapor barrier jacket tape.

C. Attachment: For rectangular ducts over 24 inches wide, duct insulation shall be additionally secured to the bottom of the ductwork with mechanical fasteners on 18 inch centers to reduce sagging. Washers shall be applied without compressing the insulation. Protruding ends or fasteners shall be cut off flush after washers are installed. All seams, joints, penetrations, and damage to the facing shall be sealed with joint sealing tape or vapor retardant mastic or appropriate joint sealing tape.

3.3 PIPE INSULATION INSTALLATION

A. Types and Thickness: Insulate all piping with insulation type and thickness as specified in “Part 2 - Products”. All piping shall be insulated except where specifically excluded.

B. General: All ends shall be firmly butted together and secured with joint sealing tape. All jacket laps and joint sealing tape shall be secured with outward clinch staples at 4 inch spacing, or by use of a suitable adhesive. Installation shall provide a continuous sealed vapor barrier over all surfaces; seal all jacket penetrations with vapor barrier mastic or vapor barrier jacket tape.

C. Elastomeric Pipe Insulation: Install with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. A brush coating of adhesive shall be applied to both butt ends to be joined and to both split surfaces to be sealed. Adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Provide added tape wrap around insulation to ensure seam and joint closure. Insulation that can be pulled

apart one hour (or more) after adhesive installation shall be replaced. Provide metal jacketing over outdoor exposed insulation.

D. Pipe Hangers: Provide insulation tight up to pre-insulated pipe supports at pipe hangers, seal all joints with joint sealing tape. Pre-insulated pipe supports are specified in Section 20 05 29.

E. Pipe Sleeves: Run insulation continuous full size through sleeve. Coordinate work with fire seals and confirm fire seal system is approved for use with insulated pipes; see Section 20 05 30.

F. Metal Jacketing:
   1. Applications: Provide metal jacket over piping insulation for the following:
      a. Exposed rain leaders in occupied areas; from finished floor and up 8 feet.
      b. Outdoor exposed piping.
   2. Outdoor Installation: Where installed on outdoor piping locate seams on bottom side of horizontal piping. Seal all jacket seams to provide a completely weatherproof enclosure; water tight.

END OF SECTION 200700

SECTION 200800

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 Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Commissioning of Mechanical Systems.

B. Documentation.

1.3 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Qualifications: Submit qualifications of the firm proposed to perform the commissioning work and for the individuals that will be assigned.

C. Commissioning Data:
1. Commissioning plan.
2. Commissioning preliminary report.
3. Commissioning final report.

1.4 GENERAL REQUIREMENTS

A. General: Commissioning shall be done by a Company which specializes in this work and independent and separate from the Companies installing the systems to be commissioned.

B. Company Experience: The Company providing the commissioning work shall be experienced in commissioning HVAC control systems, and have commissioned at least five similar projects in the last three years. Company shall be certified for such work by AABC, NEBB, AEE, BCA, or ASHRAE.

C. Individual Experience: The individuals performing the commissioning work shall have at least five years experience in commissioning, with the individual in the field in charge or the work having commissioned at least five similar projects in the last three years.

D. Deferred Test: Tests may be deferred to allow for proper climatic or other conditions.

1.5 REFERENCES

A. AABC: Associated Air Balance Council.

B. AEE: Association of Energy Engineers.

C. BCA: Building Commissioning Association.

D. NEBB: National Environmental Balancing Bureau.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. General: Provide commissioning as required by code and as specified herein.

B. Building Occupancy: Building or portions thereof, required by code to be commissioned, shall not be considered ready for occupancy until such time that the Engineer and building official determine that the preliminary commissioning report required by this Section has been completed.

3.2 HVAC SYSTEMS

A. General: HVAC equipment and HVAC control systems shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved plans and specifications.

B. Sequences: Sequences of operation shall be functionally tested to ensure they operate in accordance with approved plans and specifications.

C. Conditions: Testing shall affirm operation during actual or simulated winter and summer design conditions and during full outside air conditions.

D. HVAC Equipment: Equipment functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:
   1. All modes as described in the sequence of operation.
   2. Redundant or automatic back-up mode.
   3. Performance of alarms.
   4. Mode of operation upon a loss of power and restoration of power.

E. HVAC Controls: HVAC control systems shall be tested to document that control devices, components, equipment, and systems are calibrated, adjusted, and operate in accordance with approved plans and specifications. Sequence of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.

3.3 DOCUMENTATION

A. Format:
   1. Hard Copy: Provide reports in 8-1/2 x 11 format, in 3 ring notebooks, with labeled cover and spine, clean legible, and logically organized with table of contents, divider tabs, and names of companies involved in the project, commissioning company name, commissioning personnel, and contact information. Provide 3 copies per Divisions 00 and 01.
   2. Electronic: Provide copy in *.pdf format; submit with closeout documents per Divisions 00 and 01.

B. Test Plan: Prepare a written commissioning test plan and submit for approval prior to beginning commissioning work. Test plan to include:
   1. Equipment and systems to be tested.
   2. Roles and responsibilities of individuals performing the commissioning and of others involved in the project.
   3. Functional test procedures and forms.

4. Conditions under which the test shall be performed (for example, winter design conditions, full outside air, etc.).
5. Expected systems' response or acceptance criteria for each procedure.
6. Time schedule for performance of the work; including any deferred tests.
7. Forms as required by the WSEC or AHJ.

C. Preliminary Commissioning Report:
1. General: A preliminary report shall be issued to identify issues preventing the commissioning work from being completed. If all commissioning work can be fully completed and the final report completed, a preliminary report is not required.
2. Report: Compile all system and commissioning data; including all reviews, inspections, test procedures, and tests. Report shall include field notes of commissioning activities, equipment and system data, test procedures, tests performed, actual results as compared to expected (or specified) results, WSEC and any AHJ required commissioning forms (completed to the extent possible).
3. Items to Complete: The preliminary report shall identify items needed in order to complete the commissioning, including:
    a. Deficiencies found during testing required by this Section, which have not been corrected at the time of report preparation.
    b. Deferred tests which cannot be performed at the time of report preparation due to climatic (or other) conditions.
    c. Climate (or other) conditions required for performance of the deferred tests, and the anticipated date of each deferred test.
    d. Proposed schedule for completion of report.

D. Final Commissioning Report: Complete all commissioning work not previously completed and included in the preliminary report. Provide a complete final report with all systems and commissioning data; including test plan, all reviews, inspections, test procedures, tests, and results. Final report shall include all documentation required for the preliminary report and documentation regarding resolution of previous coted deficiencies.

END OF SECTION 200800

SECTION 230933

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Control System Design.

B. Control System for Building Heating, Ventilation, Air Conditioning, Exhaust.

C. Control Devices, Components, and Wiring.

D. Testing, Adjustment, and Commissioning.

E. Owner Training.

1.3 SUBMITTALS

A. General: Shall comply with Section 20 05 00.

B. Product Data: Submit product information on all items to be used.

C. Shop Drawings: Submit a complete set of shop drawings prior to installation containing the following information: interconnect drawings showing all wiring and control connections; control panel details; arrangement of devices in panels; schedule of dampers with sizes and where used; sequence of operation for all equipment; location of all control devices on scaled building plans; and list of actuators with sizes and where used.

D. Operation and Maintenance Manuals: See Section 20 02 00. In addition to the information required by that Section and Division 01, provide (for inclusion in the Manual) the following:

E. System description.
1. Complete sequence of operation.
2. Reduced size (11" x 17") copies of record drawings.
3. Submittal data on all products.

1.4 GENERAL REQUIREMENTS

A. Design and Installation: The control system is design/build type; all design is by the Contractor with the system providing the features and sequences specified. The entire control system shall be designed and installed by skilled control system designers, electricians and mechanics, all of whom are properly trained and qualified for the work they perform.

B. Sole Responsibility: One single Contractor shall be responsible to design, furnish and install the complete Section 23 09 33 control system.

C. Sequence: System shall have sequence of operation as specified in Section 23 09 93.

D. VRF System Coordination: Coordinate and interface with VRF system controls (Section 23 81 27). Where time schedule control is required, use time schedule control signal from the VRF system.

1.5 WARRANTY

A. Warranty: After completion of the installation of the control system and acceptance by the Owner, the system shall be warranted as free against defects in manufacturing, workmanship and materials for a period of two years from date of substantial completion. In addition, the system shall be warranted to provide the sequence of operation and basic features specified, with the accuracy and flexibility also specified. The system shall be repaired or replaced, including materials and labor, if in Owner's and Engineer's reasonable opinion, system is other than as warranted.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Acceptable Manufacturers.

B. Thermostats and Temperature Sensors: Honeywell, Paragon, Johnson Controls, Ruskin.

C. Actuators: Belimo, Honeywell, Johnson Controls.

D. Dampers: Ruskin, Greenheck.

E. Carbon Dioxide Sensors: Honeywell, Vaisla.

F. Control Accessories: Idec, Hoffman, McDonnell, Tridelta, Edwards, Mamac, Penn, Belimo, Honeywell, Johnson Controls, Leviton, Arrow-Hart, Alerton.

2.2 BASIC SYSTEM

A. System Type: The system shall be an electronic or electric type.

2.3 THERMOSTATS

A. Thermostats: Solid state type, specifically designed for commercial use. Unit (and related relay module, and controls) shall allow for features and control as required by the sequence of operation. Thermostat shall have means for setpoint adjustment. Thermostat control output type shall match controlled equipment requirements; i.e. staged type or proportional. Provide wall or duct sensor, as indicated. Room wall thermostats shall have setpoint display and room temperature display.

B. Accessories: Provide control accessories as required to properly sense the medium being controlled, allow for proper mounting, and system connections. Provide accessories as required to work with connected equipment and control devices.

2.4 CONTROL DAMPERS

A. Type: Dampers shall be parallel blade or opposed blade type, as selected by contractor to best suit application (unless a specific type is indicated).

B. Leakage: Class 1A leakage rated in accordance with AMCA 511 (or better, as required by Code).

C. Construction: Construct of galvanized steel, except where installed in ducts of stainless steel or aluminum construction or handling corrosive air, shall be of stainless steel or aluminum construction (to match duct material). All materials in contact with the airstream shall be suitable for the conditions without deterioration. Provide special coatings as necessary to provide corrosion resistance. Frame shall be minimum 16 gauge.

D. Blades: Single blade type, not exceeding 6 inches in width,16 gauge, with neoprene, extruded vinyl or butyl rubber edge seals and flexible metal jamb seals; linkage interconnecting all blades and actuator axle.

E. Bearings: Nylon, molded synthetic or oil impregnated sintered metal bearings (or other materials as conditions require).

2.5 ACTUATORS

A. Type: Actuators shall be a brushless DC motor type controlled by a microprocessor.

B. Operation: Shall be compatible with control devices used with to provide specified sequence and system features. Run time shall be constant, independent of torque. Actuator shall have manual positioning mechanism and control direction of rotation switch accessible on its cover. Provide with auxiliary switches as required for sequence of operation. Actuator shall be proportional or two position type, as required for application.

C. Sizing: Provide actuator with sufficient power and torque to suit items being controlled and allow proper operation against system pressures liable to be encountered. Actuator shall be capable of driving controlled items from full closed to full open in less than 15 seconds.

D. Spring Return: All actuators shall spring return upon power interruption: The spring return position shall be a “fail safe" position as dictated by freeze, fire, temperature protection, energy saving, or safe operating requirements. Outside air dampers shall spring return closed; return air dampers shall spring return open. VAV terminal units and zone dampers do not require spring return actuators.

E. Accessories: Units shall be complete with all linkages, brackets, and hardware required for mounting and to allow for proper control and operation.

2.6 CARBON DIOXIDE SENSOR – WALL

A. Type: Wall mounted non-dispersive infrared (NDIR) type carbon dioxide sensor. Honeywell C7232A Series (or approved).

B. Performance: Measuring range 0 to 2000 ppm CO_2, accuracy plus or minus 5% of full scale. Shall have long term stability of 5 years (i.e. no more than 5% of full scale error after 5 year operation).

C. Display: LCD display showing measured CO_2 levels.

D. Housing: ABS molded plastic housing, color white, with vent openings.

E. Output: Shall provide 4 to 20 mA, and 0 to 10 Vdc outputs, selectable by output selection jumpers and SPST normally open relay output.

2.7 ACCESSORIES

A. Wiring and Conduit: Shall comply with Division 26 specifications and with code. Wiring that performs code required life safety shutdown of equipment or fire alarm interface shall comply with NFPA standards and local codes for fire alarm system wiring.

B. Labels:
   1. General: Shall comply with Section 20 05 00.
   2. Control Devices: Labels on control devices shall use the same designation that appears on the control shop drawings and an indication as to purpose; except that devices in finished rooms shall be labeled as to the generic item controlled for better user understanding (i.e. “Room Exhaust Fan”, “Hood Fan”).

3. Wiring: Wiring labels shall be the self-laminating or heat shrink type with numbering, lettering, or an alpha-numeric identifier indicating the wire signal/power purpose and matching the designation that is used on the control drawings.

C. Control Cabinet: Wall mounted, NEMA construction type to suit application, minimum 14 gauge sheet metal, hinged front door with latch. Size as required to house controls.

D. Relays: Shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dust-proof enclosure. Relays shall have Hand-Off-Auto switch, and LED's (or pilot lights) to indicate the energized mode. Relays shall be rated for a minimum life of one million cycles. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays should be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Contact rating, and configuration selected to suit application.

E. Miscellaneous Components/Sensors/Transmitters/Transformers: Shall be manufacturer's standard, designed for application in commercial building HVAC control systems, compatible with other components so as to provide sequence of operation specified.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Provide all devices, sensors, relays, switches, dampers, actuators, conduit, tubing, wiring, motor starters and all other devices required to provide a complete integrated control system with the sequence of operation and features as specified. It is the Contractor's responsibility to coordinate with other trades for the installation of control devices in systems installed by others.

B. Installation: Install all control components in accordance with manufacturer's instructions and recommendations and best professional practices.

C. Coordination: Coordinate work with other trades to ensure that all trades have the information necessary so that they may properly install any necessary control components, interconnect with control components, and install their work to accommodate controls. Identify all items requiring ceiling or wall access doors (or other special requirements) to trade installing access doors or performing related work.

D. Space Requirements and Locations: Carefully check space requirements and coordinate with other trades to ensure that items can be installed in the allotted spaces, including above finished suspended ceilings. Adjust locations of panels, equipment, devices, and the like, to accommodate work and prevent interferences. Determine the exact route and location of wiring, conduit and other control devices prior to beginning work.

E. Mounting: Mount controls adjacent to associated equipment on vibration free elements on free standing fabricated supports; mount and locate for best access.

F. Control Cabinets: All electrical devices, relays, and components shall be installed in protective covers (i.e. control cabinets), except where installed concealed above ceilings a cover is not required. Controls/devices shall be logically assembled in cabinet, with all devices and cabinet labeled.

G. Thermostats: Room thermostats shall be mounted 4'-0" above finished floor unless indicated otherwise. Thermostats shall connect to the HVAC unit (or exhaust fan) serving the space the thermostat is located in, unless indicated otherwise. Not all thermostats are shown on the drawings and those shown are preliminary only. Contractor shall indicate all final thermostat locations on submittal drawings. Contractor is responsible to coordinate locations to avoid tackboards, casework, and other interferences.

H. Power: It shall be the responsibility of this Contractor to provide power for all control devices requiring power. Coordinate with the Division 26 Contractor to arrange for necessary power circuits. All control devices shall obtain power from circuits dedicated to control power.

I. Wiring, Conduit and Electrical:
   1. General: Provide all electrical wiring and devices in accordance with applicable codes and Division 26 requirements.
   2. Conduit: All wiring shall be installed in conduit and in accordance with Division 26 specifications, except that low voltage wiring within ceiling plenum spaces, mechanical mezzanines, and attics may be installed without conduit. Wiring in walls shall be in conduit.
   3. Wire Labeling: Label or code wiring at each end to show location of the opposite end. Each point of all field terminal strips shall be permanently labeled or coded to show the instrument of item served. Color coded cable with cable diagrams may be used to accomplish cable identification and terminal strip.
   4. Service Loop: Provide minimum of 6” extra wiring at all wiring terminations for ease of future maintenance/servicing. Such extra wiring shall be neatly coiled/bundled to allow for uncoiling when the connected equipment is serviced.
   5. Workmanship: Install all conduit and wiring parallel to building lines, in neat bundles, supported at not less than 5 foot intervals.

J. Component Labeling: All control components, except regular room thermostats, shall be equipped with name plates to identify each control component. Components in finished rooms shall be labeled as to generic item controlled for better user understanding; other devices shall be labeled with the same designation which appears on the Control Diagrams. Contractor shall submit list of proposed labeling prior to installing. Reference Section 20 05 00.

K. Thermostat Setpoints: Thermostat Setpoints (all adjustable) shall be as follows unless indicated otherwise:

Occupied Heating	70 degrees F
Unoccupied Heating	65 degrees F
Occupied Cooling	75 degrees F
Unoccupied Cooling	85 degrees F

L. Motor Starters: Shall be by Division 26; except for loads 1/2 hp and less which shall be by this Section.

M. Device Duct Installation: All control devices installed in ductwork shall be positively anchored and attached to the ductwork by mechanical means (fasteners, straps, unistrut, etc).

N. Miscellaneous Controls: Provide all miscellaneous control items as noted in the Contract Documents. Provide all necessary control wiring between items for proper control.

3.2 INSTALLER COMMISSIONING

A. General: The commissioning specified in this paragraph is independent and separate of the commissioning work of Section 20 08 00 and is to be provided by the Section 23 09 33 system installer.

B. Commissioning:
   1. General: Check all system connections and control components for proper installation. Provide testing of the control system to verify proper system operation and that the specified sequences of operation are provided. Commissioning shall include checking system under all modes of operation, documenting system performance, making corrections as required for proper operation, and re-testing as needed to obtain final proper operation.
   2. Dampers: Verify all dampers operate through their full range of motion and in the proper direction in response to controls signals.

3. Sensors/Thermostats: Check measurements of temperature sensors, thermostats, pressure sensors and other devices against independent readings to confirm proper operation and sensor locations. Readjust sensor locations as necessary to account for field conditions that may cause inaccurate measurements.
4. Calibration: Calibrate items as necessary to allow for their proper operation.
5. Adjustments: Adjust system settings as needed to allow for best system operation, consistent with the specified sequences and for facilities of the type the system serves.

C. Start-Up: Coordinate all system and equipment start-up with other trades. Start-up systems in accordance with equipment manufacturer's instructions and in conjunction with trades that installed the items being controlled, so that they (or manufacturer's representatives) are present at start-up. Operate and configure the controls for safe equipment start-up and so that equipment operates in a controlled manner. See equipment specification sections for equipment start-up requirements. Test and observe all equipment being controlled during start-up to confirm proper controls operation.

3.3 OTHER COMMISSIONING

A. Coordination: Coordinate with other firms providing commissioning services; operate the control systems as needed by these other firms to allow for their commissioning work. See Section 20 08 00.

3.4 OWNER INSTRUCTION

A. Owner Instruction: Provide instruction to Owner on the operation and maintenance of the control system. Provide field demonstrations and show Owner the locations of all control devices; explain and demonstrate how system adjustments are made; explain and demonstrate system sequences of operation.

END OF SECTION 230933

SECTION 230993

SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Sequence of Operation.

1.3 SUBMITTALS

A. General: Shall comply with Section 20 05 00.

B. Sequence: Submit complete description of sequence of operation. Sequence submitted shall not be a direct copy of the sequence specified herein, but shall be written to reflect the actual control sequence provided.

C. Shop Drawings: Provide complete control system shop drawings.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. General: Provide complete control system with sequences of operation as specified. All mechanical equipment shall be automatically controlled by the Division 23 control system, unless specifically indicated otherwise. Where no sequence of operation is indicated submit a proposed sequence for Engineer review; such sequences shall match the intended equipment use, code, and ASHRAE standards for the type of equipment and application.

B. Time Control: Control system shall provide time schedule control (i.e. occupied/unoccupied/ warm-up modes switching) for all mechanical equipment. Provide independent occupied/unoccupied schedules and optimum start (i.e. warm-up) cycle for each HVAC units (unless noted otherwise), all fans having time schedule, and all heaters. Except that exhaust fans serving adjacent restroom areas may share time schedules.

C. Warm-up Control: Control system shall provide warm-up switching for all HVAC units and items indicated as having a warm-up cycle.

D. Adjustability: All temperature setpoints and time control settings shall be adjustable.

E. Thermostats: Various thermostats are not shown on the drawings but are required per the sequence of operation specified. Coordinate with Engineer for location of all such thermostats prior to installing. Indicate proposed locations on submittals.

F. Average Thermostats: Where average thermostats are indicated on plans combine and average temperature requirements from each sensor and use average requirements to control equipment.

G. Miscellaneous Items: See plans for units with motorized dampers in the ducts and miscellaneous other items requiring control.

3.2 EXHAUST FANS

A. General: See "Control" column on Fan Schedule for which of the following control methods apply to each fan.

B. Thermostat: Fans shall run when temperature rises above setpoint, and shall be off once space temperature falls 2 degrees F or more below setpoint.

3.3 PUMPS

A. Domestic HW Circulation Pumps: Pump shall be enabled to operate by aquastat furnished with pump.

3.4 ELECTRIC HEATERS – DUCT TYPE

A. Duct Heater: Enable duct heaters via outside air temperature; when OA is less than 65 deg F (adjustable) heater is enabled. Duct thermostat will control SCR heater control to provide 67 deg plus or minus 2 degree deadband) DAT; adjustable DAT and deadband. Interlock heater with DOAS supply fan so heater only operates when fan is on.

B. Interlock: Shall be hard-wire interlocked with the supply fan on the unit which serves the heater, to only allow heater operation when the unit’s fan is proven on. Provide differential pressure switch or CT’s at unit fan to provide interlock and proof of operation.

3.5 MISCELLANEOUS CONTROLS

A. Water Heaters: Shall be controlled by integral thermostat provided with unit. Set for temperature as noted in water heater schedule.

B. CO2 Damper: Control via space CO2 sensor, modulate damper to maintain setpoint. Set minimum position for airflow noted.

END OF SECTION 230993

SECTION 232128

HVAC CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Cooling Coil Condensate Drains.

B. Overflow, Miscellaneous Drains.

C. Fabricated P-Traps.

D. Condensate Pumps.

E. Testing and Inspection.

1.3 SUBMITTALS

A. Submittals shall comply with Section 20 05 00.

B. Submit product information on all items to be used.

1.4 REFERENCES

A. ASME B 16.15: Cast Bronze Threaded Fitting Classes 125 and 250.

B. ASME B 16.18: Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B 16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ASME B 16.23: Cast Copper Alloy Solder Drainage Fittings.

E. ASME B 16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV).

F. ASTM B 32: Solder Metal.

G. ASTM B 88: Seamless Copper Water Tube.

H. ASTM B 306: Copper Drainage Tube (DWV).

I. ASTM D 1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

J. ASTM D 2466: Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

K. ASTM D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

L. ASTM D 2665: Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, 2.01, Acceptable Manufacturers.

B. Pipe and Fittings: Mueller, Cerro, Tyler, US Pipe, Charlotte Pipe and Foundry, Pacific States Pipe, Atlantic States, Spears Manufacturing, Cresline Northwest.

C. Fabricated P-Trap: Rectorseal.

D. Condensate Pumps: Little Giant.

2.2 PIPE AND FITTINGS - MATERIALS

A. Copper DWV Pipe and Fittings: Copper drainage tube per ASTM B 306. Wrought copper and wrought copper alloy solder joint fittings per ASME B 16.29; or cast copper alloy solder joint fittings per ASME B 16.23.

B. Copper Pipe and Fittings: Seamless copper water tube, tube L or M, per ASTM B 88. Solder joint wrought copper and bronze fittings per ASME B 16.22 cast copper alloy fittings per ASME B 16.18, and cast bronze threaded fittings per ASME B 16.15 with 95/5 tin-antimony solder per ASTM B 32.

C. PVC DWV Pipe and Fittings: Polyvinyl chloride drain waste and vent pipe and fittings per ASTM D 2665, with solvent cement joints. Solvent cement shall comply with ASTM D 2564.

D. PVC Pipe and Fittings: Polyvinyl chloride pipe, schedule 40, per ASTM D 1785. Solvent cement socket type fittings per ASTM D 2466. Solvent cement shall comply with ASTM D 2564.

2.3 PIPE AND FITTINGS - APPLICATION

A. Cooling Condensate Drains: Copper DWV, copper, PVC DWV, or PVC.

B. Miscellaneous Drains: Copper DWV, copper, PVC DWV, or PVC. Except that handling acidic or corrosive fluids shall be PVC.

2.4 FABRICATED P-TRAPS

A. Type: Factory fabricated p-trap with dual cleanouts and clear trap, for cooling coil condensate. Rectorseal “EZ Trap” (or approved).

B. Construction: Fabricated of schedule 40 PVC, with transparent plastic trap portion. Portion connection to HVAC unit (or coil) drain shall consist of a PVC cross, with top and side cleanouts having caps with integral retaining strap and ring. Outlet portion shall consist of PVC tee fitting, with top portion able to serve as vent.

C. Size: 3/4-inch unless indicated otherwise. Trap heights shall be sized to suit HVAC unit static pressures, unit configuration (i.e. blow through or draw through), and be consistent with HVAC unit manufacturers installation recommendations.

D. Cleaning Brush: Provide with bristled flexible shaft cleaning brush, sized for cleaning of p-trap.

2.5 CONDENSATE PUMP

A. Type: Automatic condensate pump with integral tank; for pumping cooling coil condensate, combustion condensate and similar fluids. Little Giant VCMA, VCMX or VCL series (or approved).

B. Capacity: Pump shall be rated to pump minimum of 1.4 gallons per hour per ton of unit cooling capacity served (e.g. 10 ton unit shall have a 1.4 x 10 = 14 gph capacity) at 15 feet of head (unless a different capacity is indicated). Pumps serving combustion condensate shall have a capacity of 25 gph per 1000 MBH of equipment capacity at 15 feet of head (unless a different capacity is indicated). Tank shall be 1/2 gallon capacity (unless indicated otherwise). Unit shall be rated for continuous operation.

C. Construction: Tank body and pump shall be constructed of oil resistant polypropylene or ABS, with discharge check valve, and float for pump on/off control, factory wired.

D. Accessories: Provide with overflow safety switch for wiring to low voltage controls to stop HVAC unit on high condensate (or to indicate an alarm).

E. Electrical: Provide with integral electric motor, having thermal overload protection, for use with 115 volt or 230 volt (as required to suit available power) AC single phase power, with minimum 6-foot 3-prong grounded plug.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of all items shall comply with code, best professional practices, and manufacturers written installation instructions.

B. Provide all piping as indicated and as required for all drip pans, unit condensate drains, unit p-traps, and miscellaneous drains and vent connections to all items requiring such drains (i.e. HVAC units, furnaces, boilers, AC units, etc.).

C. Coordinate installation of items with all trades that are affected by the work to avoid conflicts.

D. Consult manufacturers data and drawings for information on equipment before beginning drain rough-in.

E. Verify points of connection, elevations, and grade requirements before beginning installation or ordering materials.

F. Trap all equipment items as required by code; provide proper venting for each trap as indicated and as required by code.

G. Run piping to nearest point of drainage, or as shown on drawings. Where routing is not shown, route to nearest point of proper drainage.

3.2 PIPE AND FITTINGS

A. All piping in finished areas shall be installed concealed unless specifically noted otherwise.

B. Install piping so as not to obstruct access to any items requiring routine service, maintenance, or inspection. Offset or reroute piping as required to clear any interferences which may occur. Prior to running any exposed piping, confirm with Architect/Engineer (unless is clearly noted to be ran exposed). Install exposed piping so as not to obstruct any portion of windows, doors, doorways, passageways, or items requiring service or access.

C. Consult all drawings for location or pipe spaces, ducts, electrical equipment, structural elements, ceiling heights, door items requiring access, openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.

D. Install all drain lines with a slope of 1/4-inch per foot unless noted otherwise. Coordinate with AHJ if written approval is required for exceptions to 1/4-inch per foot slope.

E. Provide escutcheons where exposed pipe passes through walls, floors, or ceilings.

F. Install all piping parallel to equipment and nearby walls and in a neat, workmanlike manner. Horizontal straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.

G. Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary. Such offsets are typically not shown on the plans, but are required per this paragraph.

H. Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by piping and fitting manufacturer.

I. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).

J. Soldered Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.

K. PVC Pipe:
   1. Solvent Joints: The outside of the PVC pipe shall be chamfered to a minimum of 1/16 inch at approximately 22 degrees. Chemicals used must penetrate the surface of both pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.
   2. Plastic to Metal Connections: Work the metal connection first. Use a non-hardening compound on threaded connections. Use only light wrench pressure. Connections between metal and plastic are to be threaded utilizing female threaded adapters only, not male adapters.

3.3 TESTING AND INSPECTION

A. All piping shall be inspected and approved prior to being concealed or covered.

B. Provide testing as required by code. Testing shall be by water and shall comply with governing code. Testing shall be witnessed by the plumbing inspector and the Engineer's representative (at his option).

C. All leaks shall be eliminated and the system re-tested before proceeding with additional work or concealing pipe.

D. All repairs to piping shall be with new pipe and fitting material’s; no caulking of screwed joints or holes is allowed.

END OF SECTION 232128

SECTION 233100

HVAC DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Ductwork Systems.

B. Flexible Duct.

C. Acoustical Duct Lining.

D. Preparation of Duct for Service.

1.3 DEFINITIONS

A. Duct Sizes: All duct dimensions shown are inside clear dimensions. Where inside duct lining is specified or indicated, duct dimensions are to the inside face of lining.

B. Environmental Ductwork Systems: Ductwork systems that are not covered by Section 23 35 00 - Special Exhaust Systems.

1.4 QUALITY ASSURANCE

A. All work and materials shall comply with SMACNA-DCS, NAIMA-DLS, ASHRAE-F, IBC, IMC, NFPA-90A, NFPA-90B, and code. The most restrictive criteria governs.

B. Leakage Criteria: Duct system shall be constructed and sealed so that leakage does not exceed the following:
   1. Supply Duct: From fan to connection to air outlet 5%.
   2. Return Duct: 5%.
   3. Exhaust Duct: 5%.

C. Fabrication Proximity: The Contractor performing the work of this section shall have fabricating facilities located within 100 miles of the project site.

D. Drawing Review: Prior to beginning any work review all drawings, duct routing, duct connections, equipment configuration, equipment connection locations, and other work details to discover conflicts in anticipated duct arrangement and improper or incomplete connections. Review shall include the following: supply ducts not connected into return (or exhaust) ducts, ducts not crossed and improperly connected in shafts, air outlets/inlets connected to ducts, unit configuration compatible with planned duct connections, louver locations match architectural plans. Submit resolutions of such possible conflicts as submittals with shop drawings of proposed solutions; written description in lieu of shop drawings is acceptable for minor issues.

1.5 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Product Data: Submit product data for duct materials, duct lining, flexible duct, and factory fabricated items.

C. Shop Drawings: Submit shop drawing of proposed duct routing, finalizing the design indicated in the Contract Documents. Drawing shall be contractor prepared, in AutoCAD “dwg” format or in Revit “rvt” format, to scale, with all ductwork having dimensions larger than 9-inch drawn “double-line”. Prepare drawing after field investigation of existing beam sizes and other aspects of the existing structure; and after review of all new building features and coordination with other disciplines.

D. Conflict Resolution: Submit shop drawings showing proposed resolution of conflicts.

1.6 DUCT PRESSURE CLASS

A. Constant Volume Systems: Ductwork shall be constructed to the pressure class corresponding to the static pressure indicated for the fan which serves the duct system or 1-inch pressure class (plus or minus as appropriate), whichever is higher; unless noted otherwise.

1.7 REFERENCES

A. ADC-FLEX: Air Diffusion Council Flexible Duct Performance and Installation Standards.

B. ASHRAE-F: ASHRAE Handbook of Fundamentals.

C. ASTM A 653: Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

D. ASTM A 924: General Requirements for Steel Sheet Metallic-Coated by the Hot-Dip Process.

E. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.

F. IMC: International Mechanical Code.

G. NAIMA-DLS: North American Insulation Manufacturers Association Fibrous Duct Liner Standards, 1st Edition.

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

I. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

J. SMACNA-DCS: SMACNA HVAC Duct Construction Standards, 3rd Edition.

K. UL 181: Underwriter Laboratories Factory-Made Air Ducts and Air Connectors.

L. UL 181A: Underwriter Laboratories Closure Systems for Use with Rigid Air Ducts.

M. UL 181B: Underwriter Laboratories Closure Systems for Use with Flexible Air Ducts and Air Connectors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Sheet Metal: All domestic manufacturers.

C. Spin-in Fittings and ATTO: Sheet Metal Connectors Inc., United McGill, Royal Metal Products, Airflow Products Inc.

D. Gasketing: Preson, Insulfab, Duraco.

E. Duct Sealant and Tape: Carlisle (Hardcast), Ductmate, Benjamin Foster, Grace Construction Products, United McGill, Polymer Adhesives Sealant Systems, RCD Corporation, Nashua, 3M.

F. Flexible Duct: Flexible Technology Inc., JP Lamborn Co.; Hart & Cooley, Thermaflex.

G. Acoustical Duct Lining: Johns-Manville.

2.2 GENERAL MATERIALS

A. Ducts: Construct of galvanized sheet steel, suitable for lock forming without flaking or cracking, conforming to ASTM A653 and A924, having a zinc coating of 0.90 ounces total per square foot for both sides of a sheet, corresponding to coating G90.

B. Fasteners: Steel construction, electroplated zinc coated, having strength properties adequate for the application, compatible with materials being joined, and in accordance with SMACNA-DCS. Where exposed to corrosive conditions shall be of Type 304 or 316 stainless steel. Type to meet duct pressure class and duct leakage requirements. Where used for the support and anchorage of ducts shall comply with Section 20 05 29, with independent test reports regarding strength.

C. Spin-in Fittings: Factory fabricated of galvanized steel with die-formed mounting groove and damper with raised damper quadrant where ducts are to be insulated. Collar length for flexible duct attachment shall be at least 2" long.

D. Air-Tight Take-Off Fittings (ATTO): Factory fabricated branch duct connector, of galvanized steel. Flange shall be 1-1/2” wide with 1/8” self-adhesive gasket and pre-drilled fastener holes. Collar length for flexible duct attachment shall be at least 2” long. Where used on round duct mains, shall be saddle type appropriately sized for main duct diameter.

E. Draw Bands:
1. Metal: Worm gear type clamp, constructed of galvanized steel, stainless steel, or aluminum; minimum 1/2-inch wide band; suitable for 200 pound loading.
2. Non-Metal: Nylon “zip-tie” with self-locking ability, designed for flexible duct usage, minimum 1/4 inch wide, rated for 175 pound load, suitable for temperatures from 0 to 185 deg F; listed per UL181B and labeled “UL181B-C”.

F. Gasketing: Vinyl nitrile, vinyl neoprene, or neoprene nitrile PVC blend; designed for HVAC use with size to suit the application having minimum 1.5-inch width at equipment roof curb applications. Fire hazard rating not to exceed 25 for flame spread and 50 for smoke development per ASTM E 84.

G. Duct Sealant/Mastic: Water based duct sealant, listed per UL 181B-M and UL 181A-M, suitable for indoor and outdoor use. Fire resistant with a flame spread rating of 5 or less, and a smoke developed rating of 0. Sealant shall be resistant to ultraviolet radiation and ozone. Fiberglass mesh shall be minimum 0.006-inches thick, with minimum 9 x 9 weaves per inch, and 2-inch width; for use with mastic in sealing ductwork. Sealant system shall be suitable for duct system pressure class and materials used with. Carlisle Hardcast “Versa-Grip 181”.

H. Foil Tape: Foil back adhesive tape, listed per UL181A-P and UL181B-FX, with listing labeled on tape outer foil face. Minimum 3-inch width for metal-to-metal applications; minimum 2-inch width for flexible duct applications. 3M No. 3340 or Nashua No. 324A.

2.3 DUCT FABRICATION

A. Duct Gauge and Reinforcement: Shall be as shown in SMACNA-DCS according to the pressure classification of the system and the duct dimensions; with heavier gauge duct used as required to minimize duct reinforcement to suit space available and other project constraints. In no case shall ducts be constructed of less than 26 gauge material.

B. Joints and Seams: Construct in accordance with SMACNA-DCS, code requirements, and these specifications (more stringent governs). Ducts shall be constructed and sealed so that the leakage criteria is not exceeded. Round ducts shall be the spiral seam type; except that branch ducts to individual air inlets/outlets less than 16" diameter may be of other types as allowed by SMACNA-DCS. Coordinate joint spacing with duct reinforcement requirements so that transverse joints having the required stiffness may be incorporated in the reinforcement spacing schedule. Round duct transverse joints shall be made with beaded sleeve joints or flanged connections in accordance with SMACNA-DCS; except that branch ducts to individual air inlets/outlets less than 16" diameter may use other joining methods as are allowed by SMACNA-DCS.

C. Elbows and Tees: Shall be long-radius type with a center-line radius not less than 1-1/2 times the width or diameter of the duct. Where space does not permit the use of long-radius elbows, short-radius or square elbows with turning vanes may be used. Elbows in round duct systems with duct pressure class above 2-inches shall be stamped type, welded segmented type, or standing seam segmented type.

D. Transitions: Increase duct sizes gradually. Transitions for diverging air flow shall be made with each side pitched out not more than 22.5 degrees. Transitions for converging air flow shall be made with each side pitched in not more than 30 degrees. Except that eccentric transitions for round to flat oval may have up to a 45 degree pitch.

E. Branch Connections: Shall comply with SMACNA-DCS, and as required herein.
   1. Rectangular-to-Rectangular: Rectangular take-off with 45 degree angle on “inside” of take-off, minimum 4" length. Reference SMANCA-DCS Figure 4-6. Close corner openings.
   2. Rectangular-to-Round:
      a. Serving Individual Air Inlet/Outlet: Spin-in type connector or air-tight take-off (unless a different fitting type is specifically noted).
      b. Serving Branch Duct: Rectangular to round transition, with maximum degree pitch as specified for transitions. Rectangular end size shall have free area no less than round end. Rectangular connection to rectangular main shall be made as specified for “Rectangular-to-Rectangular” connections.
      c. Serving Individual VAV Terminal Unit: Conical type connector, with connector 2" larger on one end and maximum 15 degree pitch on sides.
   3. Round-to-Round:
      a. Serving Individual VAV Terminal Unit: Conical type connector (or conical tee fitting), with connection at the main duct 2" larger than the end serving the VAV terminal unit, and a maximum 15 degree pitch on sides; or “Lo-Loss” tee fitting, equivalent to that manufactured by United McGill.
      b. Other Connections: Air-tight take-off or constructed in accordance with SMACNA-DCS and recognized professional practices.
   4. Other Connections: In accordance with SMACNA-DCS and recognized professional practices.

F. Ductmate Systems:
   1. Rectangular Duct: Transverse duct joints may be made with Ductmate System, or approved equal. System shall consist of companion flanges of 20 gauge galvanized steel with an integral polymer mastic seal; corner pieces of 12 gauge G90 galvanized steel; 20 gauge G90 galvanized cleats; closed cell, high density gasket type; and galvanized carriage bolts with

hex nuts. The flanges shall be securely fastened to the duct walls using self-drilling screws, rivets or spot welding. Fastener spacing shall be as recommended by the manufacturer for the size of duct and the pressure class. The raw duct ends shall be properly seated in the integral mastic seal. A continuous strip of gasket tape, size 1/4" x 3/4", shall be installed between the mating flanges of the companion angles at each transverse joint; and the joint shall be made up using 3/8-inch diameter x 1-inch long plated bolts and nuts. Galvanized drive-on or snap-on cleats shall be used at spacing recommended by the manufacturer.

2. Round Duct: Transverse duct joints may be made with Ductmate “Spiralmate” system, or approved equal. System shall consist of galvanized steel round connector flanges (fitting inside each duct section to be joined) and an exterior galvanized steel closure ring with tightening bolt to form an airtight duct connection and join flanges together. Duct connector flanges shall have non-hardening integral mastic to seal between flanges and duct, and a neoprene gasket to seal flange faces.

G. Lined Ductwork:

1. Rectangular Ducts: Contractor Fabricated ductwork with interior duct lining. Duct fabrication and liner installation shall comply with NAIMA-DLS. Lining material shall comply with paragraph titled “Duct Lining” in this specification section.
2. Round and Oval Ducts: Shall consist of acoustic insulation in between a perforated interior duct liner and solid exterior duct. Acoustic insulation shall be 1-inch thick, except where noted to be greater. Duct sections shall connect by mechanical means to maintain positive concentricity of liner with duct. All fittings and transitions shall have perforated inner liner (except where noted otherwise). Lining material shall comply with paragraph titled “Duct Lining” in this specification section. United McGill "Acousti-k27" (or approved).

2.4 FLEXIBLE DUCT

A. Type: Factory insulated fully lined flexible duct.

B. Construction: Double-ply neoprene coated polyester fabric hose, reinforced with a steel wire helix. Black color. Fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E84.

C. Thermal Characteristics: Certified thermal resistance “R” of 4.2 Hr-SF-deg F/Btu, rated in accordance with ADC-FLEX. Except where duct is installed in an unconditioned area (and where required by code) provide certified thermal resistance “R” of 8 Hr-SF-deg F/Btu, rated in accordance with ADC-FLEX.

D. Working Pressure: As required to suit maximum pressure to be encountered on system, but no less than 4-inch wc positive, 0.5-inch wc negative.

E. Length: Shall not exceed 8 feet where used on duct systems with a pressure class of 2-inches and less; maximum 5 feet length on higher pressure class systems.

F. Code Compliance: Comply with code and applicable standards; including NFPA 90A, NFPA 90. Shall be UL listed and labeled as a Class 1 connector per UL 181.

2.5 DUCT LINING

A. Material: Flexible, inorganic glass fiber material, bonded with thermosetting resin, maximum thermal conductivity of 0.24 Btu-inch/hr-sq. ft.-degree F at 75 degrees F, coated to prevent erosion, conforming to NAIMA-DLS and exceeding that standard as specified herein. Suitable for air temperatures to 250 degrees F, and duct velocities to 6000 feet per minute. Surface shall be coated with an acrylic coating having anti-microbial agents and factory applied edge coating. Johns-Manville “Permacote Linacoustic” (or approved).

B. Thickness: Lining shall be 1-inch thick except where noted otherwise.

C. Adhesives and Fasteners: Shall conform to NAIMA-DLS, and as suitable for the duct liner material and ductwork.

D. Fungi and Bacteria Resistance: Conform to ASTM C 1338 and ASTM G21 for fungi resistance and ASTM G 22 for bacteria resistance.

PART 3 - EXECUTION

3.1 DUCTWORK INSTALLATION

A. General: Install all ductwork with all accessories and connections to provide complete and operable duct systems, in accordance with plans and specifications. See Section 20 05 29 for hangers and supports. Provide quality assurance review of all drawings prior to beginning work (see paragraph titled Quality Assurance, this specification Section and see Section 20 05 00). Provide duct and plenum sizes and locations as shown on the drawings; except as adjusted for field conditions and work of other trades, and with prior approval of the Engineer. See Section 20 05 00 for offsets and transitions to be included in project.

B. Coordination: The Contractor shall fully coordinate the work of all trades to avoid interferences and conflicts. Due to the extremely tight spaces in portions of the building, the Contractor shall coordinate duct reinforcement spacing and supports with other trades as necessary to avoid interferences. In addition, the Contractor shall select duct gauge and reinforcement types to avoid interferences. Changes required due to lack of coordination between trades, improper spacing or selection of hangers, or improper duct gauge and reinforcement selection, shall be done at no additional cost to the owner.

C. Field Measurements: Prior to fabricating any duct materials, the Contractor shall field measure all areas where ducts will be installed to verify room available and all offsets and fittings required. Field verify connection sizes and locations to equipment, louvers, and similar items.

D. Workmanship: All work shall comply with code, SMACNA-DCS, and other applicable standards. Ducts shall be installed level (unless noted otherwise) and in neat lines with the building construction using best professional practices.

E. Exposed Ducts:
   1. All ducts are to be installed concealed unless indicated otherwise. Ducts that are exposed shall be carefully fabricated, stored, and installed for best appearance. All dents, dings, scratches and other damage shall be repaired for a high quality finished look; all dirt, debris, labels, stickers, lettering, and marks removed; and the duct completely cleaned. Any sealant shall be cleaned to form a straight and even seam adjacent to joints, have no overlap onto duct areas not needing sealant, and have all excess sealant removed (mask off adjacent areas as necessary).
   2. Outdoor exposed ducts shall have “hat” type channels installed over all joints (top and sides) to prevent entry of water.

F. Flexible Duct: May only be used where specifically shown on the plans. Attach flexible duct inner core to sheet metal duct (or connector) with draw band. For insulated type, pull insulation and outer jacket completely over the inner core (at the connection to the sheet metal duct) with outer jacket covering the inner core and tucked back at its end to provide a continuous vapor barrier cover; install draw band to secure the outer jacket and insulation. Use metal type draw bands on duct systems where duct pressure class exceeds 3-inches or where temperature or other conditions do not allow the non-metal type and where indicated; use type of metal suitable for the conditions without corrosion or other deterioration. Install flexible duct with a centerline turning radius not less than one duct diameter. Where this turning radius cannot be maintained with the flexible duct use sheet metal elbows or (at air inlets/outlets) provide a plenum having a side connection.

G. Spin-in Fittings/ATTO's: May be used for branch ducts to individual outlets only. Apply a bead of duct sealant to all spin-in fittings where fitting seals against sheet metal duct.

H. Sealing:
1. General: Use materials listed and approved for the specific application. Foil tape may only be used at duct connections to air inlets/outlets (unless specifically noted otherwise). Clean surfaces to be sealed of moisture and all contaminants. Seal joints in accordance with SMACNA-DCS, sealant manufacturer's instructions, and UL 181.
2. Ductwork: Seal to meet duct leakage criteria as follows: Seal Class B.
3. Flexible Duct: Coat connection of flexible duct to metal duct with duct sealant prior to installing the flexible duct.
4. Air Inlets/Outlets: Seal duct connections (including "cans" or plenums) at air inlets and air outlets with duct sealant or foil tape; except at louvers and exposed ducts only sealant shall be used.
5. Exterior Ductwork: Special attention and effort shall be applied to the sealing of exterior ductwork to prevent any entry of water. Sealant shall be applied to all seams and joints prior to assembly in order to provide a layer of sealant which is continuous through the joint or seam. Additional sealant shall then be applied to the exterior of the joint or seam to ensure a weathertight closure. Any leakage or damage from water leakage into duct or building shall be repaired at no additional cost to the Owner.

I. Ductmate: All "Ductmate" and similar systems shall be installed in strict accordance with manufacturer's instructions.

J. Protective Caps: Provide temporary sheetmetal caps or heavy visqueen covers over all open portions of ductwork to prevent debris, dirt, and dust from entering the ductwork. Such covers shall be installed at the end of each work shift, and shall remain in place until all work activities or events that may cause duct contamination will no longer occur.

3.2 ACOUSTICAL DUCT LINING INSTALLATION

A. General: Install acoustical duct lining in ducts to extent shown on drawings, covering all interior surfaces. Round ducts shall use factory fabricated double-wall ducts as specified.

B. Installation: Installation shall comply with NAIMA-DLS and these specifications. The liner shall be cut to assure tightly butted joints.

C. Liner Attachments: The duct liner shall be applied with a 100% coverage of adhesive. Mechanical Fasteners shall be installed flush with the liner surface, and shall be spaced in accordance NAIMA-DLS.

D. Horizontal Duct Runs: Tops of ducts over 12" wide and sides of duct over 16" high shall have liner additionally secured with mechanical fasteners.

E. Vertical Duct Runs: Any side of duct over 12" in size shall have liner additionally secured with mechanical fasteners.

F. Exposed Edges: All joints, exposed edges and any damaged areas of the liner, shall be heavily coated with fire resistant adhesive/mastic.

G. Metal Nosing: Install metal nosings on the leading edges of the liner in ducts where the velocity exceeds 4000 feet per minute.

3.3 PREPARATION FOR SERVICE

A. Cleaning: All ducts shall be wiped or blown clean of all dust and debris prior to the installation of grilles or diffusers. Notify the Engineer to allow for an inspection prior to installing grilles or diffusers.

B. Contaminated Ducts: Where ducts have been contaminated by dirt or debris during the construction process, the affected duct systems shall be cleaned by an independent firm specializing in the vacuum cleaning of ductwork. All costs associated with such cleaning shall be the responsibility of the Contractor.

END OF SECTION 233100

SECTION 233300

DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Manual Dampers.

B. Backdraft Dampers.

C. Turning Vanes.

D. Flexible Connectors.

E. Duct Access Doors.

1.3 QUALITY ASSURANCE

A. General: Comply with Section 20 05 00.

B. Workmanship: Construction and installation of all duct accessories shall comply with applicable SMACNA-DCS, and exceed those standards as noted.

C. Fire dampers, combination fire/smoke dampers, and smoke dampers shall be UL listed.

1.4 SUBMITTALS

A. General: Submittals shall comply with Section 20 05 00.

B. Product Data: Submit product information on all items to be used.

C. Sound Attenuators: Submit dynamic insertion loss and pressure drop data for all sound attenuators. Submit listing of all sound attenuators by unit served, airflow application, cfm, size, velocity, and pressure drop.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Manual Damper Hardware: Duro-Dyne, Young Regulator Co., Ventfabrics, Krueger, Rossi.

C. Backdraft Dampers: Air Balance, Ruskin, Greenheck.

D. Turning Vanes: Duro-Dyne, Aero-Dyne, Oil Capital Sheet Metal, Airsan.

E. Flexible Connections: Ventfabrics, Duro-Dyne Elgen.

F. Duct Access Doors: National Controlled Air, Ventfabrics, United-McGill, Kees, Ruskin, Vent Products, Duro-Dyne.

G. Building Access Doors: J.R. Smith, Zurn, Acudor, Elmdoor, Kees, J.C. Industries, Milcor.

2.2 MANUAL DAMPERS

A. Type: Manually adjustable volume dampers.

B. Blades: Damper blades shall be fabricated of galvanized steel or stainless steel (unless a specific material is indicated), two gages heavier than duct in which installed, and in accordance with SMACNA-DCS. Maximum blade width 12 inches; fabricate multi-blade dampers with opposed blade pattern for ducts larger than 12" x 48".

C. Regulators: Damper regulator sets shall have quadrant dial regulator with locking nut, square end bearing one side, and spring round end bearing other side (small sizes) or open end square bearing (larger sizes), axis of blade the long dimension. Multiple blade dampers shall have individual quadrants for each blade or one quadrant with interconnected blades. Regulator sets shall be Duro-Dyne model numbers (or approved equal) as follows:

Max. Blade Dimension	Duro-Dyne Regulator Set	Shaft Size
10" and less	KS-145, 145L	1/4"
11" to 14"	KSR-195, 195L	3/8"
15" to 23"	SRS-388, SB-138, KP105	3/8"
24" and larger	SRS-128, SB-112, KP105	1/2"

D. Concealed Regulator: For remote damper adjustment with finished ceiling appearance. Shall consist of self-locking regulator of cast alloy construction (with serrated core, spring washer, housing, indicator, lock nut) cast into a cylindrical housing for flush ceiling installation. Housing cover shall be of steel construction, shall telescope into the regulator housing to be flush with the finished ceiling, and be secured to the housing with two screws. Provide with extension rods, linkages, miter gears, and all accessories as needed for proper damper operation. Plain Finish. Ventfabrics No. 666, 667 or Young Regulator Co. No. 301 (or approved equal).

E. Extractor Fittings: Galvanized steel construction, 24 gauge steel blades on 2 inch centers, with worm gear operator for adjustment through face of grille. Krueger EX-88 (or approved equal).

2.3 BACKDRAFT DAMPERS

A. Type: Airflow and gravity operated backdraft dampers. Greenheck WD-100, WD-300, WD-400 (or approved equal).

B. Frame: Shall be constructed of minimum 18 gauge galvanized steel or stainless steel or minimum 0.063 thick 6063T5 extruded aluminum (unless a specific material is indicated).

C. Blades: Shall be constructed of minimum 0.025" thick formed aluminum, or stainless steel (unless a specific material is indicated), with extruded vinyl edge seals. Seals shall prevent any noise due to damper opening/closing. Bearings shall be synthetic polycarbonate or acetal type. Damper linkage shall be with aluminum or galvanized steel tiebar. Dampers with vertical airflow shall be spring assist type.

D. Configuration: For horizontal or vertical airflow as indicated on plans.

E. Performance:
1. General: Dampers shall be tested in accordance with AMCA standards.
2. Pressure Drop: Not to exceed 0.05 inch w.g. at 250 fpm with vertical airflow; and not to exceed 0.07 inch w.g. pressure drop for horizontal airflow.

3. Leakage: Dampers used to prevent the entry of outdoor air shall have air leakage no greater than 20 cfm/sf at 1-in w.g. where not less than 24-inches in any dimension, and no greater than 40 cfm/sf where less than 24 inches in any dimension; when tested in accordance with AMCA 500D.
4. Pressure and Velocity Ratings: Shall suit maximum velocity and pressure differential to which dampers will be subjected; but no less than 1500 fpm and 1.0-in w.g. differential pressure.

2.4 TURNING VANES

A. Type: Galvanized steel turning vanes to guide airflow through duct elbows to minimize pressure drop.

B. Construction: Turning vanes shall comply with SMACNA-DCS. Vanes shall be fabricated of minimum 26 gauge galvanized steel; rails shall be fabricated of minimum 24 gauge galvanized steel. For duct widths less than 12 inches, vanes may be single wall construction; for widths 12” and greater, vanes shall be double wall "airfoil" type.

C. Spacing: Turning vanes shall be equally spaced in accordance with SMACNA-DCS, parallel to each other, and securely attached to runners.

D. Unequal Elbows: For elbows where the inlet and outlet dimensions are not the same, modify vane shape or angle to provide optimum turning.

2.5 FLEXIBLE CONNECTORS

A. Type: Flexible fabric type connectors, to provide vibration isolation at equipment duct connections and to allow for movement in duct systems.

B. Fabric:
1. Width: Minimum 3” wide except at equipment 3 hp or larger with external vibration isolators fabric shall be minimum 6” wide.
2. Indoor Applications: Flexible woven glass fiber fabric with neoprene coating, minimum 22 oz/sq. yard, 500 lbs x 450 lbs tensile strength. Suitable for temperatures from -40 to 200 deg F.
3. Outdoor Applications and Where Exposed to Chemicals: Flexible woven glass fiber fabric with hypalon coating, ozone resistant, 24 oz/sq. yard, 225 lbs x 300 lbs tensile strength. Suitable for temperatures from -40 to 250 deg F.
4. High Temperature Applications: Fiberglass/satin weave with Teflon coating; temperature rating of minimum 500 deg F and to suit application, 400 lbs x 300 lbs tensile strength.

C. Metal Collars: Minimum 24 gauge galvanized steel 3” wide metal edge connectors, each side of fabric, connected to fabric by folded over metal seam. Fabricate of same material as ducts connected to.

D. Fire/Smoke Rating: Flame spread rating not over 25, and smoke developed rating not higher than 50; complying with IMC requirements and NFPA standards.

2.6 DUCT ACCESS DOORS

A. Construction: Access doors shall be of double wall construction, made with minimum 24 gage galvanized steel, tight fitting, with sealing gasket, and cam locks (or may be hinged type with latches).

B. Size:
1. General: Access doors shall be of sufficient size so that items concealed in duct can be serviced and inspected, and shall be adequately sized to allow complete removal of the item being served (where removal cannot be made without disturbing fixed ductwork).

2. Minimum size: Doors shall be minimum 14" x 14". Where duct size will not accommodate this size door, the doors shall be made as large as practicable.
3. Large Sizes: Doors larger than 14" x 14" shall have a minimum of 4 cam locks (or where hinged type is used, have a minimum of two (2) latches).

C. Insulation: Doors in insulated ducts shall be insulated type, with minimum 1 inch thick fiberglass insulation.

D. Round Ducts: Access doors on round ducts shall use either lined rectangular tap off with rectangular access door or curved insulated access door (for insulated duct); or curved type un-insulated access door (for un-insulated duct).

2.7 BUILDING ACCESS DOORS

A. Type: Hinged lockable steel access doors, for wall or ceiling installation.

B. Construction: Minimum 16 gauge frame and 14 gauge door, concealed hinge, cam and cylinder lock, anchoring provisions, and 1” wide frame to conceal rough building opening. Provide of 18-8 stainless steel construction with No. 4 finish where used in restrooms, locker rooms, kitchens, and similar "wet" areas. Provide of steel construction with prime coated finish in other areas.

C. Size: Size shall be 12" x 12" (unless indicated otherwise) but shall be large enough to allow necessary access to item being served and sized to allow removal of the item (where access door is the only means of removal without disturbing fixed construction).

D. Fire Rating: Door shall maintain fire rating of element installed in; reference drawings for required rating.

E. Keys: Access doors shall all be keyed alike. Provide two (2) keys for each door.

PART 3 - EXECUTION

3.1 MANUAL DAMPERS

A. General: Dampers shall be fabricated and installed in accordance with SMACNA-DCS requirements for volume dampers.

B. Locations: Install dampers at locations shown on the drawings in branch ducts to all air inlets/outlets, and at all other locations as required by the Balancer to allow for the balancing of the system. Locate dampers at a point where the damper is most accessible; orient damper regulator for best access.

C. Non Accessible Dampers: Provide flush-mounted concealed type damper quadrants for ducts concealed in walls or non-removable ceilings and where a remote damper operator has been indicated.

D. Initial Setting: Set and lock all dampers in the full open position prior to balancing.

E. Extractor Fittings: Provide where indicated on the plans and at wall type inlets/outlets where such outlets cannot be served by a manual damper in the branch duct.

F. Identification: Provide orange surveyor’s tape, approximately 18” long tied to each damper regulator (except not required on dampers in ducts exposed to view in finished areas).

3.2 BACKDRAFT DAMPERS

A. General: Install in accordance with manufacturer's instructions.

B. Application: Use counterbalanced type at all non-fan powered building exhausts and reliefs; all others shall be the standard type.

C. Adjustments: Adjust counterbalanced backdraft dampers to be open at 0.07” building pressure (unless noted otherwise), or as necessary for proper space pressurization and building air balance. Coordinate work and settings with air balancer.

D. Access Doors: Provide access doors to backdraft dampers, except that where damper is installed immediately behind a ceiling or wall grille, and is accessible by removing this grille, an access door is not required.

3.3 TURNING VANES

A. General: Install turning vanes in all duct elbows and “T” fittings, and at locations shown on the drawings.

B. Attachment: Securely attach turning vane runners to ductwork.

3.4 FLEXIBLE CONNECTORS

A. General: Provide flexible connectors at all duct connections to all equipment, where ducts of dissimilar metals are connected, and where shown on the drawings. Except that flexible connectors are not required on internally spring isolated fans where the fan is located in a separate mechanical room and a flexible connector has not been shown.

B. Round: For round ducts, the flexible material may be secured by zinc-coated, iron clinch type draw bands directly to adjoining duct; or with normal duct joining methods and using metal collars furnished with flexible connectors.

C. Slack: Install flexible connections with sufficient slack to permit 1 inch of horizontal or vertical movement of ducts or equipment at flexible connection point without stretching the flexible material. At building expansion joints install sufficient flexible material to allow for 2 inch movement in any direction; provide two flexible connectors separated by a 12 inch section of duct.

D. Outdoors: Where installed exposed to outside weather, provide a galvanized "hat" channel protecting top and vertical stretches of flexible connector from sunlight and weather.

3.5 DUCT ACCESS DOORS

A. General: Provide duct access doors at all automatic control dampers, fire dampers, fire/smoke dampers, smoke dampers, backdraft dampers, all duct coils, thermostats, filters, control devices, and any other components in the duct system that require service or inspection.

B. Size and Location: Access doors shall be of sufficient size and so located so that the concealed items may be serviced and inspected or completely removed and replaced.

3.6 BUILDING ACCESS DOORS

A. General: Provide access doors in walls, floors, ceilings, etc. as indicated on the drawings and where needed to provide service access or maintenance to duct access doors, backdraft dampers, damper actuators, automatic dampers, coils, control devices, fans, HVAC equipment and similar items.

B. Coordination: Consult architectural drawings and coordinate location and installation of access doors with trades which are affected by the installation.

END OF SECTION 233300

SECTION 233400

FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Ceiling Exhaust Fans.

1.3 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Product Data: Submit manufacturer's product data for all items to be used. Submit fan curves showing SP vs. CFM and BHP vs. CFM with system operating point clearly marked.

1.4 QUALITY ASSURANCE

A. AMCA: Fans shall bear the AMCA certified seal unless indicated otherwise.

1.5 REFERENCES

A. AMCA 210: Laboratory Methods of Testing Fans for Ratings.

B. IMC: International Mechanical Code.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. General: Products shall comply with Section 20 05 00. See Section 20 05 00, Paragraph 2.01 for Acceptable Manufacturer requirements.

B. Exhaust Fans: Greenheck, Twin City, Penn Barry, Cook, Carnes.

2.2 GENERAL

A. Drives: Shall be sized for not less than 150% of the rated motor horsepower.

B. Motors:
1. General: Comply with Section 20 05 00. Motors on belt drive fans shall have adjustable supports for adjusting belt tension. Motor speed controllers shall be VFD type except where solid state speed controllers are provided or EC motors with integral speed controller. VFD’s shall be as specified in Division 25.
2. Fractional Horsepower Motors: Shall be the electronically commutated (EC) type with speed control where noted and where non-EC motors are not available which comply with code

motor efficiency requirements. Unless noted otherwise, provide with manual speed control mounted at the motor for air balancers use. Motors shall be specifically designed for fan applications, have permanently lubricated ball bearings, speed controllable down to 20%, and have internal thermal overload protection.

C. Performance: Fan capacity shall not be less than the values listed on the drawings. Fan performance shall be based on laboratory tests conducted in accordance with AMCA 210.

D. Outlets and Inlets: Fans shall be furnished with attachment angles and/or flanges as required for attaching ductwork and/or flexible connections indicated.

E. Fan Types: The type of each fan is indicated on the Fan Schedule, under the "Type" column, and corresponds to the types specified herein.

F. Fan Arrangement and Drive: Shall be as indicated. Select motor and drive access side to allow best access and to suit available space.

G. Electrical: Fan disconnects and motor starters shall comply with Division 26 specifications. Disconnects furnished with fan shall come factory wired to motor or shall be field wired by Division 23.

H. Finish: All fans shall have factory applied enamel finish (manufacturer's standard color, unless noted otherwise) over a rust inhibiting primer base coat; except a painted finish is not required on rooftop type fans of aluminum or equivalent corrosion resistant construction.

I. Backdraft Dampers:
   1. General: Provide all exhaust fans with backdraft dampers.
   2. Ceiling Exhaust and Ceiling Cabinet Fans: Manufacturer’s standard backdraft damper, factory installed integral with the fan, to close automatically to prevent airflow in the opposite direction than intended when fan is off; or type as specified for “Other Fans” below.

2.3 CEILING EXHAUST FAN

A. Type: Centrifugal exhaust fan with integral grille. Greenheck Model SP or approved.

B. Housing: Shall be constructed of galvanized steel, with discharge backdraft damper, and 1/2" - 1-1/2 lb/cubic foot density fiberglass duct liner insulation. Fan shall have either top or horizontal discharge (as required). Housing shall have adjustable mounting brackets to match ceiling thickness.

C. Grille: Shall be of aluminum or steel construction, with white baked-on enamel finish; except that fans with scheduled capacity less than 250 cfm capacity may have grilles constructed of high impact polystyrene.

D. Fan Wheel: Shall be forward curved, centrifugal type.

E. Drive: Fan shall be direct drive, with motor mounted on resilient elastic supports.

F. Speed Control: Speed controller allowing speed reduction down to 50% of maximum.

G. Disconnect: Factory mounted on side of cabinet or within unit but so as to be accessible when unit is installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with Section 20 05 00. Install in accordance with manufacturer's written installation instructions, code, applicable standards and best construction practices.

B. Locations: Install fans at locations indicated and in accordance with the Contract Documents.

C. Speed Controls: Fans with speed controllers shall have the speed controller mounted on the fan housing unless another location is indicated on the drawings (for use by Balancer). Install VFD's at accessible locations near item served.

D. Connections: Provide flexible connections in ductwork connections to all fans.

E. Start-Up: Prior to start-up inspect fans and installation to confirm proper installation and system is ready for start-up. Arrange other trades to be present as needed (i.e. balancer, electrician, etc.). Check fans for correct rotation, tighten belts to proper tension, adjust fan speeds to provide required performance, verify proper electrical and control connections, check vibration isolation (as applicable) for correct operation, and lubricate bearings per manufacturer's recommendations.

END OF SECTION 233400

SECTION 233700

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. GRD Outlets.

B. GRD Inlets.

C. Roof Caps.

D. Roof Hoods.

1.3 DEFINITIONS

A. GRD's: Grilles, Registers, and Diffusers.

1.4 REFERENCES

A. AHRI 885: Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. AMCA 500: Laboratory Methods of Testing Louvers for Rating.

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

D. ASHRAE-F: ASHRAE Handbook of Fundamentals.

E. SMACNA-DCS: HVAC Duct Construction Standards, 3rd Edition.

1.5 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Product Data: Submit product information for all items to be used.

C. Operation and Maintenance: Submit operation and maintenance data and submittal data for inclusion in project O&M Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Grilles, Registers and Diffusers: Titus, MetalAire, Krueger, Price, Tuttle & Bailey, Kees, Carnes.

C. Roof Caps: Greenheck, Nutone, Carnes.

D. Roof Hoods: Greenheck, Carnes, Cook “TRE” Series.

2.2 GENERAL REQUIREMENTS

A. Type: Air outlets and inlets shall be of the size, type, and with number of throws as shown on the drawings; and shall match the appearance and performance of the manufacturers' models specified and scheduled on the drawings.

B. Performance: Air outlet and outlet performance shall be based on tests conducted in accordance with ASHRAE 70.

C. Sound Level: Air outlets and inlets shall not exceed a sound level of NC 30 for the size indicated and airflow rate application. Sound levels shall be determined in accordance with AHRI 885 and ASHRAE-F.

D. Finish: Grilles, Registers and Diffusers shall have factory applied finish, color as selected by Architect/Engineer, except where indicated to have a brushed aluminum finish (or other finish type). Finish shall be an anodic acrylic paint, baked on, with a pencil hardness HB to H. Pint shall pass a 90 hour ASTM B117 salt spray test, 250 hour ASTM D870 water immersion test, and an ASTM D2794 reverse impact test with at least a 50 inch-pound force applied.

E. Frame Style: Provide air outlets and inlets with frame style to match ceiling or wall construction installed in. Where supply air outlets or inlets are installed in T-bar ceiling systems, they shall be factory installed in 2' x 2' or 2' x 4' metal panel to match ceiling layout. Where installed against gypsum board surface, brick or similar hard surface, or where exposed, provide with 1-1/4-inch wide outer border. Where space does not permit installing 2' x 2' metal panel, provide outlets or inlets with 1-1/4-inch wide outer border. Where air outlets are installed adjacent to surface mounted light fixtures, outlets shall have 4-inch deep drop frames. (See reflected ceiling plan and/or electrical lighting plan for ceiling and lighting types).

F. Transfer Grilles: Ceiling transfer grilles shall be same as ceiling exhaust grilles (CEG) unless noted otherwise; wall transfer grilles (WTG) shall be same as wall exhaust grilles (WEG) (unless noted otherwise).

G. Construction: Air outlets and inlets shall be of steel or aluminum construction except that:
1. Where noted to be constructed of a specific material, shall be as noted.
2. In assemblies with a required fire rating and required to have fire dampers shall be of steel construction.
3. In wet areas or subject to condensation (i.e., locker rooms, restrooms, kitchens, exterior soffits, etc.), where not used in fire rated assemblies, shall be of aluminum construction.
4. Air outlets and inlets in the same room, area, or within common view shall be constructed of the same material.

2.3 SUPPLY AIR OUTLETS

A. Ceiling Diffuser (CD): Aluminum or steel construction, modular core, with multiple curved (or angled) discharge blades, and square neck. Cores shall consist of four separate sections which can be repositioned to allow for one, two, three or four way discharges. Cores shall be easily removed with no tools required. Krueger 1240 Series, Titus MCD, MCD-AA Series (or approved equal).

B. Ceiling Diffuser Register (CDR): Same as CD but with opposed blade damper.

C. Ventilation Ceiling Diffuser (VCD): Non-corrosive construction, with integral adjustable core for varying air volume. Core shall spin in and out with no tools required. Shall have compression spring tabs for round duct installation, no screws required.

D. Round Ceiling Diffuser (RCD): Aluminum construction, 4 cones, with inner cone assembly adjustable for three different discharge settings (from horizontal to vertical airflow). Inner 3 core assembly shall be positively latched in place, and be easily removed. Core shall be attached to diffuser body by a safety chain (or cable). Provide with radial opposed blade or butterfly type damper, operable from diffuser face. Krueger 5RM2 Series (or approved equal).

2.4 RETURN AIR INLETS

A. Ceiling Return Grille (CRG): Aluminum construction, "cube-core" or "egg-crate" type, with 0.025-inch thick x 1/2-inch deep strips mechanically joined to form 1/2" x 1/2" x 1/2" cubes. Krueger Series EGC5. Titus Series 50F.

B. Ceiling Return Register (CRR): Same as CRG but with opposed blade damper operable from face of register.

2.5 EXHAUST AIR INLETS

A. Ceiling Exhaust Grille (CEG): Same as CRG.

B. Ceiling Exhaust Register (CER): Same as CEG but with opposed blade damper operable from face of register.

2.6 ROOF HOODS

A. Type: Low silhouette roof vent, with arched top. Greenheck Model FGI, FGR (or approved).

B. Construction: Aluminum, fabricated with arched interlocking panels, rounded edges, vertical sides, designed for mounting on factory fabricated roof curbs, with horizontal 1/2-inch mesh wire bird screen, and integral galvanized steel supports for rigidity. Roof vents used for intake shall have provision for installing 2-inch thick aluminum filters.

C. Performance: Hood pressure drop shall not exceed 0.05 inch wc at 500 feet per minute (ducted model, with screen, no filters).

D. Size: Roof vents shall have throat size as indicated on the plans (or size to match the connecting duct sizes indicated).

E. Finish: Baked enamel, color as selected by Architect.

F. Roof Curb: Shall be constructed of minimum 18 gauge galvanized steel or 0.064-inch thick aluminum, of all-welded construction, with top wooden nailer held in place by metal wrap-around, and internally insulated with minimum 1/2-inch thick rigid fiberglass. Size of curb shall match roof vent. Provide curb type as required to match roof type (i.e., with built-in cant and step height to allow for roof insulation; sloped base; etc.). Greenheck Model GPR, GPS, GPF, or approved equal.

G. Dampers: Gravity Type as specified in Section 23 33 00.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install air outlets and inlets in locations indicated and so as to conform with building features and coordinated with other work. See hangers and supports specification Section for supports and additional requirements.

B. Location Verification: Verify all air inlet/outlet locations with building features and other trades prior to installing any duct systems that will connect to the air outlets/inlets. For locations where air

inlet/outlet location is noted to be verified, or location is not clear, develop shop drawings showing the proposed location, or the location that best suits field conditions, and submit for review.

C. Connections: Furnish all necessary screws, clips, duct collars, and transitions required to allow for the installation and connection of ductwork to all air outlets/inlets. Connect all ductwork to air inlets and outlets with fasteners, minimum one each side and in compliance with SMACNA-DCS. See ductwork specification Section for sealing and additional requirements.

D. Painting:
   1. Paint ductwork and accessories which are visible behind air outlets and inlets flat black. Painting to include ductwork, duct liner, turning vanes, liner attachments, and all visible items (including fastening pins for duct lining).
   2. Coordinate with the Division 09 Contractor for any necessary painting of air outlets/inlets/louvers prior to installation.

END OF SECTION 233700

SECTION 237223

DOAS UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Dedicated Outdoor Air System Unit (DOAS).

B. Start-up.

1.3 SUBMITTALS

A. General: Submittals shall comply with Section 20 05 00.

B. Product Data: Submit product information on unit including fan curves, coil performance, unit construction details, wiring diagram, data showing energy recovery, filter data, and weight.

C. Shop Drawing: Submit drawings of unit showing all dimensions, locations of unit components, and point of connection of all utilities.

1.4 GENERAL REQUIREMENTS

A. Standardization: All units of the same type shall be the product of the same manufacturer.

B. Substituted Equipment: The drawings show design configuration based on a particular manufacturer's equipment (i.e. basis of design). Use of another manufacturer's equipment (i.e. substituted equipment) that is configured different from what is shown will require redesign of mechanical ductwork, piping, electrical, structural, unit support systems, and general building construction to accommodate the substituted equipment. Such redesign shall meet the requirements and have the approval of the Architect/Engineer prior to fabrication. Contractor shall submit complete shop drawings showing all alternate unit installation plans and details; shop drawings shall comply with Section 20 05 00. The redesign shall be equal or superior in all respects to the Architect/Engineer's design (as judged by the Architect/Engineer), including such aspects as equipment access, ease of maintenance, duct connection locations, unit electrical requirements, noise considerations, vibration unit performance, and similar concerns. Cost of redesign and all additional costs incurred to accommodate the substitutional equipment shall be borne by the contractor. Contractor is cautioned that certain aspects of the equipment cannot be fully evaluated until items are installed and operational, and all added costs after installation to make units equal to the basis of design shall be by the Contractor.

1.5 REFERENCES

A. AMCA 230: Laboratory Methods of Testing Air Circulating Fans for Rating and Certification.

B. AHRI 1060: Standard for Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.

1.6 WARRANTY

A. General: See Division 00 and Section 20 05 00 for basic warranty requirements.

B. Extended Warranty: The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances or normal use, for a period of ten years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two years from the date of installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. Energy Recovery Ventilator: RenewAire.

2.2 GENERAL

A. Guards: Exposed openings into fan housings shall be protected with substantial metal screens or gratings. Electrical components with shock potential shall be physically protected and labeled (label as to hazard and items being accessed).

B. Fan Balancing: The shaft and fan wheel(s) shall be factory statically and dynamically balanced.

C. Motors: Shall be UL listed and comply with Section 20 05 00. Motor efficiency shall comply with Code. Motors shall have integral thermal protection with automatic reset.

D. Outlets and Inlets: Equipment shall be furnished with attachment angles and/or flanges to allow for attaching external ductwork.

E. Fan Performance: Shall be based on laboratory tests conducted in accordance with AMCA 230. Fan capacity shall not be less than the values scheduled on the drawings and shall be constructed to be able to operate with total pressures 20% higher than that indicated.

F. Controls: Coordinate with Division 25 Contractor for required interfaces between air handling equipment and building control system.

G. Gasketing: Where units are furnished in sections, unit manufacturer shall furnish unit with gasketing to allow sealing of adjoining sections.

H. Sound Tests: Shall be done by fan manufacturer in an AMCA certified sound testing laboratory. Sound tests shall be conducted in accordance with AMCA 300. Provide necessary testing and calculations to develop required sound data. Tested sound power levels shall not exceed specified levels by more than 3 dB in any octave band.

I. Factory Tests: Every unit shall be factory tested prior to shipping. Tests shall include (as a minimum): Motor dielectric voltage-withstand test, unit dielectric voltage-withstand test, continuity of internal control circuits test, unit amperage test, proper fan operation.

2.3 DOAS

A. Type: Outdoor energy recovery ventilator using fixed plate enthalpy heat exchanger.

B. General:

1. Unit shall be complete single package, self contained factory assembled unit, requiring only electrical, duct, and control connections to operate.
2. Capacity: Shall be as scheduled at the conditions noted.
3. Unit configuration shall be as shown on plans.

C. Cabinet:
1. General: Constructed of minimum 20 gauge G-90 galvanized steel, reinforced and constructed for maximum anticipated static pressures involved, but no less than 4" w.c. with cabinet leakage less than 1% of scheduled airflow.
2. Liner: Interior of cabinet shall be insulated with minimum 2-inch thick, 4 pound per cubic foot density foil scrim faced fiberglass insulation to provide a cleanable surface. Double-wall construction with foam injected insulation and interior 20 gauge G-90 galvanized steel is also acceptable.
3. Access Doors: Constructed same as cabinet, size to access unit internals, with full perimeter gasket. Doors shall be opened by releasing multiple latches or similar method requiring no tools.

D. Fan(s): Integral supply and exhaust fans, direct drive, steel or aluminum construction, multi-blade centrifugal type. Motors shall be ECM type.

E. Energy Recovery Core:
1. General: Total enthalpy type, capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air. No condensate drains shall be required.
2. Certifications: The energy recovery cores used in these products shall be third party Certified by AHRI 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacturer’s published performance for airflow, static pressure, temperature and total effectiveness, outdoor air (OACF) and exhaust air leakage (EATR). OACF shall be no more than 1.02 and EATR shall be a 0% against balanced airflow.

F. Filters: Unit shall be provided with filter racks for accommodating 2” thick filters (unless noted otherwise), with minimum filter area (or sizes) and MERV as scheduled on the drawings. Access to filters shall be through unit access doors.

G. Electrical:
1. General: Unit shall be for use with single point electrical power connection unless indicated otherwise on the electrical drawings. Unit shall be furnished with all necessary wiring, raceway, transformers, contactors, relays, motor starters, and accessories with power and controls connected to all unit devices for proper unit operation and with the specified sequence. Electrical shall comply with NEC and local code requirements. Access panels to unit electrical components shall be hinged with latches (or equivalent device), requiring no tools to open.
2. Disconnects: Unit shall have a main fused power disconnect. Disconnects shall comply with NEC, and be accessible from outside unit enclosure.
3. Motor Starters: Each fan shall be provided with a motor starter (unless a VFD is indicated), with overcurrent protection complying with NEC requirements, hand-off-auto switch, and disconnect.
4. Wiring: Wiring shall be color coded and labeled to indicate termination points. Wiring diagram shall be posted in unit interior compartment.

H. Controls: Unit control shall be by Section 23 81 27 (unless otherwise noted); unit shall have factory controls to provide necessary safeties and to allow for control by Section 23 81 27. Section 23 81 27 shall enable unit fans when unit “run” terminals are connected. Unit shall be furnished with all

necessary relays, starters, wiring terminal strips, timers, safety devices, etc. to allow for the sequence of operation as specified in Section 23 81 27 using the Section 23 81 27 control system. Unit control wiring shall be color coded and numbered corresponding to unit's wiring diagram. Access panels to unit controls shall be hinged with latches (or equivalent device), requiring no tools to open.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install the units as shown on the drawings, in accordance with manufacturer's instructions, Code, and best construction practices.

B. Locations: Install at locations indicated, to allow for maintenance access and proper clearances.

C. Duct Connections: Provide flexible connections in ductwork connections to units.

D. Controls: Connect equipment to controls furnished under Section 23 81 27. DOAS shall operate when VRF commands.

3.2 START-UP

A. Initial Checks: Prior to operating units, checks shall be made to insure that adequate voltage, duct connections, electrical connections, control connections, and other items as listed by the manufacturer are properly provided/connected and ready to ensure safe and proper unit operation.

B. Testing and Adjustment: Operate unit to test for proper operation, including fan rotation, and correct interface to other controls.

END OF SECTION 237223

SECTION 200200

OPERATION AND MAINTENANCE MANUAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. VRF Split System Heat Pumps.

B. Refrigerant Piping.

C. System Controls and Control System Design.

D. System Interface to Other Controls and Equipment.

E. Complete VRF System Controls.

F. VRF Start-up and Commissioning.

G. HVAC Controls Checkouts.

1.3 QUALITY ASSURANCE

A. Listing: Units shall be listed by an approved testing agency for the use and application intended.

B. Ratings and Certification: Unit performances shall be tested and rated in accordance with AHRI Standards and shall be AHRI certified.

C. Energy Efficiencies: Equipment energy efficiencies shall not be less than code requirements and shall exceed code efficiencies as indicated.

D. Installer Qualifications:
1. General: The installer shall have experience installing VRF systems by the manufacturer being used for this project. Installer shall be certified by the VRF system manufacturer as a “certified installer”.
2. Refrigeration Components: Shall be installed by a licensed refrigeration mechanic having experience with VRF systems, and the work shall be supervised by personnel trained by the VRF system manufacturer.
3. Controls: Control work shall be done by individual trained and certified by the VRF manufacturer for the installation of the specified controls.

1.4 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Product Data: Provide complete product information submittals on all units; include performance capacities as a function of indoor and outdoor coil db/wb temperatures and indoor coil air flow

rates, supplementary heater capacity, fan performance (cfm vs. esp), and information on all filters and accessories.

C. Refrigerant Piping: Submit proposed refrigerant pipe sizes, schematic of routing, and refrigerant system accessories.

D. Control Shop Drawings: Submit shop drawings of complete control system, including the following information: interconnect drawings showing all wiring and control connections, all control device locations, sequence of operation for all controlled systems, building floor plans with all proposed thermostat and other control device locations shown.

E. Installer Qualifications: Submit qualifications of the personnel installing the refrigeration system components and the system controls (when requested by the Engineer).

F. Support Frame: Provide dimensions and details on outdoor unit steel support frame.

1.5 GENERAL REQUIREMENTS

A. System Type: System shall be a Variable Refrigerant Flow (VRF) heat pump system, allowing for simultaneous heating and cooling modes operation of indoor units, with indoor units operating independently of other indoor units, changeover from one mode to the other (heating to cooling, cooling to heating) with no interruption to system operation, and the recovery of energy between units in different modes. The system shall be capable of accommodating a range of the sum of all indoor unit capacity, from 50% to 150% of outdoor unit capacity.

B. Standardization: In interests of Owner's standardization, all system heat pumps and heat pump controls shall be the product of the same manufacturer.

C. Alternate Manufacturers: The project has been designed around equipment by the manufacturer scheduled on the drawings. Alternate manufacturers may be used (see Acceptable Manufacturers, Section 20 05 00); however, any redesign (from what is shown on the drawing) to mechanical, electrical, structural, or general construction to accommodate such an alternate manufacturer shall be provided by the Contractor. Furthermore, such redesign shall meet the requirements and have the approval of the Architect/Engineer prior to fabrication. Contractor shall submit complete shop drawings showing all alternate installation plans and details; shop drawings shall comply with Section 20 05 00. The redesign shall be equal or superior in all respects to the Architect/Engineer's design, including such aspects as equipment access, ease of maintenance, duct connection locations, unit electrical requirements, noise considerations, unit performance, and similar concerns. Cost of redesign and all additional costs incurred to accommodate the alternate heat pumps shall be borne by the Contractor.

D. Refrigerant Pipe Sizing: Due to the use of proprietary selection criteria by the heat pump manufacturers, the heat pump supplier shall size all refrigerant piping between the indoor and outdoor units and provide such sizes to the installing Contractors prior to the bid date. The heat pump supplier shall also determine the need for any additional accumulators, solenoid valves, and similar accessories and size/select such devices and inform potential installing contractors to allow proper bids. The heat pump supplier is obligated to furnish complete heat pump units, with properly calculated pipe sizes and accessories so as to allow the unit performances as scheduled.

E. Electrical and Controls: Component wiring shall comply with NEC and be color coded and numbered and match unit wiring diagrams. All necessary terminal blocks, fuse, wiring, junction boxes and electrical/control accessories shall be factory installed within the unit cabinet (unless noted otherwise).

1.6 WARRANTY

A. General: See Division 00 and 01 for general warranty requirements.

B. Warranty - VRF System Equipment:

1. Basic: Entire heat pump (outdoor and indoor sections) shall be warranted by the manufacturer to be free from all manufacturing defects and capable of providing satisfactory operation for the project warranty period. Repair and/or replacement of defective items (labor and parts) during the project warranty period shall be at no additional cost to the Owner.
2. Extended: Compressors and all coils shall be warranted by the manufacturer to be free from defects and capable of operating satisfactorily for a period of 5 years beyond the basic project warranty. Extended Warranty shall cover all warranted parts and associated shipping to the site, with repair labor by the Owner.

C. Warranty - VRF System Controls:

1. Basic: System shall be warranted for the project warranty period to provide the sequence of operation and basic features specified, with the accuracy and flexibility specified. The system shall be repaired or replaced, including materials and labor, if in Owner's reasonable opinion, system is other than as warranted.
2. Emergency Service: During the warranty period maintain a 24-hour emergency phone service and be able to respond by a trained and qualified Controls Engineer familiar with the installed system.
3. Warranty Service Allowance: Include 8 hours of control technician/programmer’s time for special service (i.e. software changes, system consultation, setting up additional trends, etc.) and other services during the warranty period as required by the Owner or Engineer. The Owner and Contractor will jointly track the amount of time used. Only time directly authorized and agreed to by the Owner may be tracked as part of this allowance. This allowance is for work outside of other required project work, and is for specific tasks assigned to the Contractor by the Owner or Engineer.
4. End of Warranty Service: At the end of the warranty period, the Contractor shall provide a re-check of the entire system operation, including calibration testing of a sample number of components and providing any necessary control adjustments for proper system operation. Such work shall be for a minimum of 8 hours on site.
5. Extended Warranty: Controls and control system shall be warranted for 2 years, beyond the project warranty period.

1.7 REFERENCES

A. AHRI 210/240: Standard for Unitary Air Conditioning and Air Source Heat Pump Equipment.

B. AHRI 350: Standard for Sound Rating of Indoor Air Conditioning Equipment.

C. AHRI 270: Standard for Sound Rating of Outdoor Unitary Equipment.

D. AHRI 1060: Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.

E. ASME B16.22: Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

F. ASME B16.26: Standard for Cast Copper Alloy Fittings for Flared Copper Tubes.

G. ASME B280: Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

B. VRF Heat Pumps: Mitsubishi, Carrier, Toshiba, Samsung, Daikin.

C. Refrigerant Pipe and Fittings: Domestic made products only.

2.2 SPLIT SYSTEM HEAT PUMP - OUTDOOR UNIT

A. Type: VRF air-to-air heat pump, outdoor section, for serving multiple indoor units.

B. Capacity: Units shall allow the indoor units to have the minimum cooling and heating capacities scheduled on the drawings at the conditions shown; rated in accordance with AHRI standards.

C. General: Unit shall be fully factory assembled and shall be complete with casing, coils, fans, compressor, piping, wiring, controls, and all other accessories required to be ready for field connections and operation. Unit shall be capable of operating in the cooling mode from 30 to 125 degrees F ambient, and in heating mode from 0 to 65 degrees F ambient. Unit shall be factory run-tested to verify proper heating, cooling, defrost, control, and fan operation.

D. Unit Casing: Shall be constructed of galvanized steel, bonderized and finished with manufacturer's standard color. Casing shall be able to withstand 960 hours per ASTM B117 criteria.

E. Compressor(s): Shall be high performance, inverter driven, modulating capacity scroll type. Compressor shall have internal overcurrent protection and thermal overload protection, high pressure safety switch, and crankcase heaters. Compressor(s) shall be mounted to avoid transmission of vibration.

F. Refrigerant Circuit: Units shall be for use with refrigerant R-410A and shall be fully charged at the factory for the piping and indoor units used with. Unit shall include an accumulator with refrigerant level sensors and controls.

G. Coils: Shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing, with a factory applied corrosion resistant finish and integral metal guard protector.

H. Fan: Shall be direct drive, variable speed propeller type with a raised guard to prevent contact with moving parts. Fan motor shall have permanently lubricated bearings and inherent overcurrent protection.

I. Electrical and Controls: Units shall be for use with power of voltage and phase as scheduled on the drawings. Unit shall have over-current protection and DC bus protection. Unit shall include all controls for units components, interconnection to other system components for automatic operation, safeties to prevent unsafe operation, to accommodate system defrost, and to allow for 8 stages of operation. Units controls shall be 24 volt.

J. Sound: Unit shall have a sound rating not higher than 60 db(A) individually, and 64 dB(A) where twinned. In "night mode" unit shall have a sound rating not higher than 50 db(A) individually, and 53 dB(A) where twinned.

2.3 SPLIT SYSTEM HEAT PUMP - INDOOR - CEILING CASSETTE

A. Type: Indoor VRF heat pump for overhead suspended installation in a ceiling (or at ceiling height).

B. General: Unit shall be fully factory assembled and shall be complete with fan, four-way discharge outlet, evaporator coil, refrigerant metering device, heavy gauge steel chassis, refrigerant piping

controls, condensate pan, drain connection, and related accessories to operate properly with VRF system.

C. Capacity: Unit shall have minimum cooling and heating capacities as scheduled on the drawings at the conditions shown and with the outdoor unit indicated; rated in accordance with AHRI standards.

D. Unit Casing: Fabricated of galvanized steel, with support provisions for hanging from building structure. Unit shall have bottom discharge grille, adjustable for two, three, or four-way discharge. Grille vane angles shall be adjustable via room wall thermostat. Exposed portion of unit shall have finished paint, manufacture's standard color.

E. Refrigerant Circuit: Shall be fully factory piped and shall include an electronic linear thermostatic expansion device to allow for both heating and cooling operation. Units shall be factory charged with dehydrated air (or an inert gas).

F. Coil: Non-ferrous construction with plate fins on copper tubing, with all joints silver brazed. Coils shall be factory tested to a minimum of 1.5 time's normal working pressure. Coil shall have corrosion resistant drain pan and drain fitting; configured to allow draining either end of unit. Unit shall have an integral condensate pump, rated for unit condensation rate and 2.5 feet of head.

G. Fan: Direct drive, multi-speed type, statically and dynamically balanced, with permanently lubricated motor, manually adjustable guide vanes for side to side discharge, and a motorized discharge louver directing air up and down automatically. Fan speed shall be adjustable via room wall thermostat to a set level, or be able to be set to vary according to heating or cooling demand.

H. Filter: Unit shall have an integral washable filter, easily removable.

I. Electrical and Controls: Unit shall be for use with power of voltage and phase as scheduled on the drawings. Unit shall include all controls for unit's components, interconnection to other system components, and to provide the specified sequence of automatic operation. Unit shall include controls providing self-diagnostic checks, auto restart (on power outage or loss of control communication), test run switch, auxiliary contacts for control of an external heat source, four digital inputs for custom control applications, and three digital outputs for custom control applications.

J. Condensate Pump:
   1. Provide unit with condensate pump. Where not available internal to unit, or where internal pump doesn't meet the pumping capacity required, provide external type, with controls, and gpm capacity to suit unit maximum condensate rate, at 10 feet of head. Provide mounting assembly, accessories for complete connections, and an architectural cover to match the finish of the unit to minimize visibility.
   2. Provide unit with high level condensate overflow sensor. Sensor shall detect high condensate levels in the indoor unit and stop indoor unit operation before an overflow can occur. Provide mounting assembly and accessories required to install on specified indoor unit.

2.4 SPLIT SYSTEM HEAT PUMP - INDOOR - WALL MOUNT

A. Type: Wall mounted indoor VRF heat pump, ductless.

B. General: Unit shall be fully factory assembled and shall be complete with fan, adjustable discharge outlet, evaporator coil, refrigerant metering device, heavy gauge steel chassis, refrigerant piping controls, condensate pan, drain connection, and related accessories to operate properly with VRF system.

C. Capacity: Units shall have minimum cooling and heating capacities as scheduled on the drawings at the conditions shown and with the outdoor unit indicated; rated in accordance with AHRI standards.

D. Unit Casing: Fabricated of galvanized steel, with wall mounting plate, and manufacturers standard white painted finish on exposed portion of unit. Unit shall have manually adjustable guide vanes for side to side discharge, and a motorized discharge louver directing air up and down automatically. Discharge louver automatic operation and position shall be adjustable via room wall thermostat.

E. Refrigerant Circuit: Shall be fully factory piped and shall include an electronic linear thermostatic expansion device to allow for both heating and cooling operation. Units shall be factory charged with dehydrated air (or an inert gas).

F. Coil: Non-ferrous construction with plate fins on copper tubing, with all joints silver brazed. Coils shall be factory tested to a minimum of 1.5 time's normal working pressure. Coil shall have corrosion resistant drain pan and drain fitting; configured to allow draining either end of unit.

G. Fan: Direct drive, multi-speed type, statically and dynamically balanced, with permanently lubricated motor. Fan speed shall be adjustable via room thermostat to a set level; or be able to be set to vary according to heating or cooling demand.

H. Filter: Unit shall have an integral washable filter, easily removable.

I. Electrical and Controls: Unit shall be for use with power of voltage and phase as scheduled on the drawings. Unit shall include all controls for unit's components, interconnection to other system components, and to provide the specified sequence of automatic operation. Unit shall include controls providing self-diagnostic checks, auto restart (on power outage or loss of control communication), test run switch, auxiliary contacts for control of an external heat source, four digital inputs for custom control applications, and three digital outputs for custom control applications.

J. Condensate Pump:
   1. Provide unit with condensate pump. Where not available internal to unit, or where internal pump doesn't meet the pumping capacity required, provide external type, with controls, and gpm capacity to suit unit maximum condensate rate, at 10 feet of head. Provide mounting assembly, accessories for complete connections, and an architectural cover to match the finish of the unit to minimize visibility.
   2. Provide unit with high level condensate overflow sensor. Sensor shall detect high condensate levels in the indoor unit and stop indoor unit operation before an overflow can occur. Provide mounting assembly and accessories required to install on specified indoor unit.

2.5 SPLIT SYSTEM HEAT PUMP - INDOOR - FAN COIL

A. Type: Suspended indoor VRF heat pump, ducted, fan coil.

B. General: Unit shall be fully factory assembled and shall be complete with fan, motor, evaporator coil, refrigerant metering device, heavy gauge steel chassis, refrigerant piping controls, condensate pan, drain connection, and related accessories to operate properly with VRF system.

C. Capacity: Units shall have minimum cooling, heating, and airflow capacities as scheduled on the drawings at the conditions shown and with the outdoor unit indicated; rated in accordance with AHRI standards.

D. Unit Casing: Fabricated of galvanized steel, with provisions for mounting. Provide with access doors.

E. Refrigerant Circuit: Shall be fully factory piped and shall include an electronic linear thermostatic expansion device to allow for both heating and cooling operation. Units shall be factory charged with dehydrated air (or an inert gas).

F. Coil: Non-ferrous construction with plate fins on copper tubing, with all joints silver brazed. Coils shall be factory tested to a minimum of 1.5 time's normal working pressure. Coil shall have corrosion resistant drain pan and drain fitting; configured to allow draining either end of unit.

G. Fan: Direct drive, multi-speed type, statically and dynamically balanced, with permanently lubricated motor. Air speed shall be adjustable via room wall thermostat to a set level, or set to vary according to heating or cooling demand.

H. Electrical and Controls: Unit shall be for use with power of voltage and phase as scheduled on the drawings. Unit shall include all controls for unit's components, interconnection to other system components, and to provide the specified sequence of automatic operation. Unit shall include controls providing self-diagnostic checks, auto restart (on power outage or loss of control communication), test run switch, auxiliary contacts for control of an external heat source, four digital inputs for custom control applications, and three digital outputs for custom control applications.

I. Condensate Pump:
   1. Provide unit with condensate pump. Where not available internal to unit, or where internal pump doesn't meet the pumping capacity required, provide external type, with controls, and gpm capacity to suit unit maximum condensate rate, at 10 feet of head. Provide mounting assembly, accessories for complete connections, and an architectural cover to match the finish of the unit to minimize visibility.
   2. Provide unit with high level condensate overflow sensor. Sensor shall detect high condensate levels in the indoor unit and stop indoor unit operation before an overflow can occur. Provide mounting assembly and accessories required to install on specified indoor unit.

2.6 BRANCH CIRCUIT CONTROLLER

A. Type: Refrigerant Branch Circuit (BC) Controller controlling refrigerant flow and with controls and accessories for system heating/cooling operation.

B. General: The BC Controller shall be fully factory assembled, and complete with all piping, valves, controls, and wiring. Unit shall be factory run tested. Provide unit size and capacity appropriate for the system and number/size of indoor units.

C. Unit Cabinet: Fabricated of galvanized steel, sized to enclose all components. An integral condensate pan and drain connection shall be provided. Provided with factory supplied condensate pump.

D. Refrigerant Circuit: Unit shall have multiple tow-position automatic refrigerant valves to control refrigerant flow, and each branch line shall have a service valve to allow servicing any indoor unit without interruption of service to other units. Unit shall have a liquid-gas separator a tube-in-tube heat exchanger. Linear electronic expansion valves shall be provided for control of refrigerant flow.

E. Electrical: Unit shall be for use with power of voltage and phase as scheduled on the drawings. Unit shall include all controls for proper operation interconnection to other system components.

2.7 VRF SYSTEM CONTROLS

A. General:

1. System shall have VRF manufacturer's controls to control all space indoor units, heat recovery unit, outdoor unit, and additional HVAC system components, as a unified system. System shall provide the sequence of operation specified.
2. The control system shall consist of a low voltage communication network of controllers and control devices, communicating over a high-speed communication bus, with a web-based operator interface. A web controller with a network interface shall gather data from the VRF and HVAC control system and generate web pages accessible through a conventional web browser for PC's connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
3. System shall be capable of email generation for remote alarm annunciation.
4. Provide all control system software, programming, and control devices to allow for the system operation, the specified sequence, specified features, and to allow remote access via a standard web browser. Provide graphics accessible by the web browser, which display the systems in a schematic fashion with system data overlayed on the graphics. Provide all software licensing to the project Owner.

B. EMCS Interface: System controls shall have BACnet interface for connection to a future building EMCS to allow the EMCS to monitor complete system operation and to allow enable/disable of the overall system components (i.e. placing in off or auto modes remotely).

C. Room Thermostats: Shall provide space temperature control for indoor units, completely independent of other indoor units. Thermostats shall include: occupant setpoint adjustment of plus or minus 3 deg F, room temperature display, room setpoint display, fan speed adjust, indoor unit diagnostics, discharge vane/louver adjust (where indoor units are specified with adjustable vanes/louvers), and related features as specified with the system equipment.

D. Master Controller:
1. General: Shall provide time schedule, warm-up, optimum start, night setback, monitoring system status, unit on/off control, unit airflow control, temperature settings, and other control functions for the system and to serve as one of the users' interface. Shall allow for system programming, start-up, trouble-shooting, setup, and provide the specified sequence of operation. Wall mounted, backlit, color touch panel, with visual display of all settings, and system diagnostics.
2. Communication Ports: Controller shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to other controllers for display of up to two hundred indoor units.
3. Scheduling:
   a. Time Schedules: The Control System shall provide time clock schedule with at least 20 time schedules. Each schedule to be 8-day type, 5 entries per day. All entries to be in 12 hour AM/PM format. The complete schedule shall be displayed at one time on the master controller for easy editing. Each time program shall be able to include on/off, high/low speeds, temperature setpoints, dduty cycle commands, as required to provide the specified sequence of operation.
   b. Holiday Schedules: A minimum of 20 holiday time schedules shall be available and shall be assigned to any number of available points. Holiday schedule shall display entire year and shall also allow for an interval holiday time, program showing holiday start date to end date (example: December 24 to January 2).
4. Warm-up Mode: Control System shall have warm-up mode prior to occupied mode on heating to pre-warm building prior to occupancy. Time of beginning warm-up cycle shall be determined by an optimum start/stop program.
5. Optimum Start/Stop: Control System shall have optimum start/stop program to reduce run time of HVAC equipment. Optimum start/stop program shall consider building mass, building temperatures, outdoor air temperatures, and other system factors in determining time of system start-up or shut-down. Program shall record previous warm-up times versus

actual warm-up times and shall adjust the program algorithm so that program calculated warm-up time corresponds to actual.

6. Standard software functions shall be available so that the user can securely log into each master controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics.

E. Sub-Controllers: Controllers providing control system equipment in conjunction with the VRF system and master controller. Controller capabilities shall be as required to provide the specified sequence of operation and communicate via the VRF control system network. Controls to include inputs/outputs as required for the application for adjustment of system setpoints, control HVAC equipment (VRF and non-VRF), detect system errors, and monitor system (and equipment) status. See specified sequence of operation for requirements and specified system features.

F. Input/Output Devices: Devices with binary and analog inputs/outputs to control general HVAC equipment in conjunction with the VRF system, master controller, and sub-controllers. Device capabilities shall be as required to provide the specified sequence of operation and communicate via the VRF control system network. See specified sequence of operation for requirements and specified system features.

G. Wiring and Conduit:
1. General: As manufacturer's system requires; complying with Division 26, and in accordance with NEC.
2. Low Voltage: Multi-conductor, 16 AWG, twisted, stranded shielded wire; unless required otherwise by the VRF system manufacturer.
3. Network Wiring: CAT-5 with RJ-45 connection; unless required otherwise by the VRF system manufacturer.

H. Labels:
1. General: Shall comply with Section 20 05 00.
2. Control Devices: Labels on control devices shall use the same designation that appears on the control shop drawings and an indication as to purpose; except that devices in finished rooms shall be labeled as to the generic item controlled for better user understanding (i.e. 'Room Exhaust Fan", "Hood Fan").
3. Wiring: Wiring labels shall be the self-laminating or heat shrink type with numbering, lettering, or an alpha-numeric identifier indicating the wire signal/power purpose and matching the designation that is used on the control drawings

I. Control Cabinets: Wall mounted, NEMA rated construction, type and rating to suit location environment, UL listed, minimum 14-gauge sheet metal, hinged front door with latch. Size as required to house controls. Controls/devices shall be logically assembled in cabinet, with all devices and cabinet labeled.

J. Relays/Contactors: Shall be the single coil electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contacts shall be doubled break silver to silver type protected by arching contact where necessary. Number of contacts and rating shall be selected for the application intended. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Relays shall have mechanical switching to allow manual operation of relay and LED light to indicate the energized state.

K. Miscellaneous Control Components: Complying with Section 20 05 00 and Division 26. Standard components, for use in commercial and institutional occupancies, rated and designed for the application and able to provide the specified sequence of operation.

L. Maintenance Tool:

1. Tool: Hardware and software to allow system monitoring and to aid technicians in system maintenance; shall monitor system operational functions, status, and settings.
2. Parameters: Tool shall enable the user to monitor and record the following parameters in a centralized system.
   a. Outdoor Unit: Operation mode (cooling only, heating only, cooling main, heating main), compressor frequency, amperages and voltages, compressor high- and low-side pressure, system temperatures, outdoor temperature, status of reversing valve.
   b. BC Controller: Valve on/off status, temperatures, pressures.
   c. Indoor Unit: Entering Air temperature, entering/leaving Refrigerant temperature, superheat/subcool temperatures, expansion valve position, room temperature setpoint, unit mode and status (heat, cool, dry, auto, fan).
3. Manual Control: The Maintenance Tool shall have be able to control the following system components manually: indoor unit, indoor unit on/off, mode (heat, cool, dry, auto, fan), room temperature setpoint, fan speed, expansion valve position, BC controller valve open/close.
4. Connections: The Maintenance Tool shall be connectable to the control system communication bus and be connectable to a PC via a USB cable.
5. Trending: Trended data from Maintenance Tool shall be available to export to a data file for offline analysis.
6. Portable PC: For use with the “Maintenance Tool”, provide as part of tool; with Windows operating system (latest available version), CPU, RAM, storage space, and communication ports to meet software and system requirements and allow for adequate trending and full maintenance operations. Submit PC to the Owner for Owner installation of Owner’s security software prior to use.

2.8 REFRIGERANT PIPING AND ACCESSORIES

A. Piping and Fittings: Rated for system pressures per VRF system manufacturer. Hard drawn ACR copper tubing per ASTM B280, Type L, with silver brazed joints and wrought copper fittings per ASME B16.22. Use only long radius elbows. Flared fittings (at equipment connections only) shall comply with ASME B16.26. Soft copper tubing may only be used on runs less than 50-feet or where necessary (i.e. when routing through sleeves, or similar poor access areas) and where acceptable to VRF system manufacturer.

B. Isolation Valves: Brass ball valve, full port, rated for system pressures and temperatures, but no less than 700 psig and -40 deg F to 300 deg F. Compatible with refrigerant used with, UL listed, with rupture proof encapsulated stem, extended copper connections for ease in brazing. Provide in configuration (i.e. angle, straight, with access port) as required to suit application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install system in accordance with code, manufacturers written installation instructions, and best construction practices. Set units in locations as shown on the drawings and maintenance to units.

B. Location and Arrangement: Install all equipment at locations and as shown on the drawings. Install so as to allow maximum access to units. Prior to selecting unit final location, confirm that: Proper unit clearances and access will be provided; no adverse airflow conditions are present; confirm location and installation details with other trades. Units shall be level and aligned with building walls. Provide welded steel frame to support outdoor units; set on spring vibration isolators and support with roof sleepers. Anchor unit to sleepers, and anchor sleepers to building structure.

C. Complete Connections: Connect and install all items shipped loose with units; provide and connect all utilities and accessories as required for proper unit operation.

D. Refrigerant Piping: Shall be silver brazed. Bleed dry nitrogen through piping during brazing to minimize oxidation. Keep all open ends of piping capped when not being worked. Soft copper shall have long radius bends; install without kinks or excess bends. Piping shall be routed concealed, except where routed outdoors and where noted. Piping shall be ran plumb and square to building walls, and in a neat professional manner.

E. Refrigerant Charge: System shall be checked for proper refrigerant charge and oil level and charged to proper levels after all leak testing and evacuation work has been completed. Refrigerant to be added to the system shall be delivered to the site in factory charged containers and charged into the system through a filter/drier.

F. Unit Protection: Units shall be protected during construction to prevent mud, dirt, paint overspray, plaster materials, and similar debris from depositing on the unit. Units shall be clean and in new condition prior to Owner acceptance.

G. Cleaning: Units shall be thoroughly cleaned of all debris prior to operation. Units shall be clean and in new condition prior to Owner acceptance.

H. Operation: Units shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete; system checkout has occurred; and the Engineer has reviewed the system and granted approval.

3.2 VRF SYSTEM CONTROLS

A. General: Installation shall comply with VRF system manufacturer written instructions and recommendations. Provide all software, hardware, licensing, sensors, relays, switches, dampers, actuators, conduit, tubing, wiring, transformers, motor starters and all other devices required to provide a complete integrated VRF control system with the system features and sequence of operation specified. Control system shall be contractor designed to comply with Contract Document requirements.

B. Room Sensors: Room sensors (i.e. thermostats) shall be mounted at an ADA accessible height (unless indicated otherwise). Thermostats shall control the equipment which affects the temperature serving the space the thermostat is located in (unless indicated otherwise). Not all room sensors are shown on the drawings and the locations shown are preliminary only. Contractor shall review all drawings, coordinate with other trades, and indicate all final proposed room sensor locations on the submittal shop drawings. Contractor is responsible for coordinating locations to avoid chalkboards, tack boards and other interferences.

C. Electrical Power:
   1. General: Provide all electrical wiring and devices in accordance with codes, and Division 26 requirements.
   2. Sources: It shall be the responsibility of the installer of the VRF control system to provide power for all VRF control devices requiring power. Coordinate with the Division 26 Contractor to arrange for necessary power circuits. System Master Controller shall obtain power from a UPS (uninterruptible power supply); unless the unit has an internal battery back-up adequate for 24 hours.
   3. Conduit: All wiring shall be installed in conduit and in accordance with Division 26, except that low voltage wiring within the ceiling plenum spaces may be ran without conduit provided that plenum rated cable is used. Install all conduit and wiring parallel to building lines.

D. Equipment Interconnect Wiring: In addition to control wiring between equipment and control devices (furnished under this Section) to accomplish the specified sequence, provide added control wiring to interconnect equipment and to interconnect equipment and associated control/safety

devices. Provide as required by the equipment manufacturers to allow for proper operation of the equipment and system.

E. Component Labeling: All control components, except regular room thermostats, shall be equipped with name plates to identify each control component. Components in finished rooms shall be labeled as to generic item controlled for better user understanding; other devices shall be labeled with the same designation which appears on the Control Diagrams. Contractor shall submit list of proposed labeling prior to installing.

F. Complete System: Provide all devices as required to allow for automatic control with sequence of operation specified. Provide all control interconnections between indoor and outdoor units, and other equipment.

G. Adjustability: All setpoints and differentials shall be adjustable. Setpoints indicated are initial settings.

H. Confirm Settings: Confirm with Owner all setpoints, all time schedules, and all other adjustable programming parameters before substantial completion.

I. Thermostats Setpoints: Shall be adjustable, with initial settings as follows unless indicated otherwise:

Occupied Heating	70 degrees F
Unoccupied Heating	65 degrees F
Occupied Cooling	76 degrees F
Unoccupied Cooling	85 degrees F

J. Sequence Terminology: Wherever the control sequences refer to an article, device or piece of equipment in the singular number, such reference shall mean to include as many of such articles, devices, or equipment as are shown on the plans, required for the sequence, or required to complete the installation. Wherever the control sequence refers to an operating stage in the singular number, such reference shall mean to include as many stages as are specified for the equipment and shall mean analog (i.e. proportional) type control where specified for the equipment (reference drawings and equipment specifications).

3.3 VRF HEAT PUMPS - SEQUENCE OF OPERATION

A. General: VRF controls shall provide time schedule control and heating/cooling/fan operation of indoor units, with BC and outdoor units automatically operating in response to system loads and needs using their integral controls.

B. Occupied Mode:
1. Fan: Indoor fan shall run continuously when heating or cooling is required; fan shall cycle to low speed (or as an option cycle off) when no heating or cooling is required.
2. Heating: Indoor heat pump section shall operate in heating as required to satisfy the space setpoint. Airflow shall vary from minimum to maximum depending on load, and shall be programmable to remain at a fixed value instead of varying.
3. Cooling: Indoor heat pump section shall operate in the cooling mode as required to satisfy the space setpoint. Airflow shall vary from minimum to maximum depending on load, and shall be programmable to remain at a fixed value instead of varying.

C. Unoccupied Mode: Indoor fan and indoor heat pump heating/cooling shall cycle on and off as required to maintain unoccupied setpoints.

D. Mode Control: Units' mode of operation shall be determined by time schedule and time schedule override; warm-up mode shall be initiated by optimum start controls.

E. Outdoor unit and Refrigerant Controller: Shall operate to provide adequate and correct refrigerant flow to serve indoor units and to reject or recover heat.

3.4 DOAS - SEQUENCE OF OPERATION

A. General: VRF controls shall provide time schedule control of the DOAS unit in conjunction with the heat pump units. DOAS mode shall match the mode for the VRF system served, except that when any indoor heat pump is in the occupied mode, the DOAS shall be on in the occupied mode.

B. Occupied Mode:
1. Fans: Supply and exhaust fans are on.
2. Outside Air and Exhaust Air Dampers: 100% open (dampers and actuators provided with units).
3. Bypass Damper and Economizer: The bypass damper shall be closed (to allow energy recovery) unless: the outside air temperature is above 60 deg F (adjustable) then the outside air bypass damper shall be activated so that outside air bypasses the energy recovery coil (for economizer cooling).

C. Unoccupied Mode: Unit shall be off.

D. Warm-up Mode: Unit shall be off.

E. Frost Control: Controlled by ERU integral controls. When the exhaust air temperature drops below the frost control setpoint (initial setting 35 deg F), the outside air damper shall bypass the energy recovery coil to prevent frost buildup due to freezing condensate.

3.5 MISCELLANEOUS - SEQUENCE OF OPERATION

A. Fire/Smoke Shutdown:
1. Smoke Detector: Provide necessary conduit, wiring, and accessories to shutdown each unit upon activation of that unit's smoke detectors. Connections shall be hardwired; independent of any control system logic, so that failure of control system or loss of control system will in no way prevent the shutdown of each unit. In addition to shutting down the unit with the alarmed smoke detector, all equipment interlocked or served by that unit shall be off. Other units shall also shut-off as required to avoid building pressure differentials and similar undesirable effects.
2. Fire Alarm System: Shut-down all air handling equipment when the building fire alarm system goes into alarm. Contacts in the fire alarm system are available for this purpose. This shut-down may be accomplished by use of control logic and is not required to be hardwired but shall be of a fail-safe nature so as to provide the necessary shut-down in case of control failure and the control components shall be rated for such purposes (as required by the AHJ).

B. Automatic Restart:
1. General: Equipment shall automatically restart after being shut-off by a power outage, fire alarm, smoke detector, or similar alarm (or fault); upon clearing of the alarm (or fault). System shall revert to its normal operation for the conditions at the time of restarting.
2. Controlled Restart: Provide controlled re-start by building wing or building floor and in a manner to prevent pressure differentials, equipment issues, or other undesirable effects. Provide time delay on the re-start of equipment 2.5 KW and larger to minimize electrical surges.

3.6 REFRIGERANT LEAK TESTING AND EVACUATION

A. Notification/Witnessing: Prior to beginning any testing, notify the Architect/Engineer when the testing will occur. The Architect/Engineer will witness (at his option) various parts of the test.

Failure to notify the Architect/Engineer will be cause to re-test all piping in the presence of a representative of the Architect/Engineer.

B. Disconnect and isolate from the system any components that may be damaged by the test pressure.

C. Connect oil-pumped, dry nitrogen to the system through a pressure reducing gauge manifold. Charge enough nitrogen into the system to raise the pressure to 50 psig. Let stand for 2 hours and check for signs of leakage. If no leakage is noted, slowly increase pressure to 300 psig (or as required by local code, whichever is higher). Tap all brazed connections with a rubber or rawhide mallet sufficiently hard to start any leak that might subsequently open from thermal expansion/contraction or vibration. Check the manifold gauge for any drop in pressure. Let the system stand pressurized for 24 hours. Re-check the manifold gauge. If no change in pressure is noted (after adjusting for temperature) the system may be considered free of leaks.

D. If leakage is suspected or apparent, check joints with a glycerin soap solution or other means to locate the leaks. Repair any leaks found by completely disassembling the connection, cleaning the fitting and remaking the connection. Re-test the system after repairs are made both with pressure (300 psi for 24 hours) and at the leak location with a glycerin soap solution or other means of determining leaks.

E. When the system has been proven free of leaks with the above methods, the system shall be completely evacuated of all air and moisture. Connect a vacuum pump to the system and pump the system down to 500 microns and let stand for a minimum of 2 hours. If the vacuum reading remains unchanged, the system may be charged with refrigerant.

F. After satisfactory pressure testing and vacuum evacuation, fully charge the system with refrigerant. Any final connections that were not subject to the full test pressure (e.g. connections at unit, etc.) shall be carefully checked with a halide or electronic leak detector after the system has been charged.

3.7 START-UP/TESTING AND ADJUSTMENT

A. Initial Checks: Prior to operating units, checks shall be made to insure that adequate voltage, air flow, duct connections, electrical connections, control connections, crankcase heaters (where applicable), and other items as listed by the manufacturer are properly provided/connected and operating to insure safe and proper unit operation.

B. Testing and Adjustment: Manufacturers representative shall provide start-up. Operate unit in various modes of operating to test for proper operation, including fan rotation, proper damper travel (where applicable), proper cooling/heating, correct interface to other controls (time clock, fans, etc.), etc. Make necessary adjustments.

C. System Commissioning: As the systems become operational, the VRF system installer shall test and observe the operation of each and every air moving and heating/cooling unit and shall adjust all controls so that the items function according to the intent of the specifications. The VRF system installer shall commission the VRF system controls, including a point-to-point check of all devices, and provide documentation substantiating the work. This commissioning work is separate from the Section 20 08 00 commissioning, and is to occur prior to the commissioning work of Section 20 08 00.

D. Report/Statement: After making all necessary system testing and adjusting, the Contractor shall submit a report to the Engineer indicating all testing/adjustment work done and comment on how system is operating. Such report shall be signed by the individual directly responsible for supervision of the installation of the control system. When the Contractor feels that the system is complete and ready for review by the Engineer, Contractor shall submit a written statement (signed

by same individuals as for report) stating that the system is in compliance with the project requirements and ready for review.

3.8 OWNER INSTRUCTION

A. General: Comply with Section 20 05 00. After all testing and adjustments have been satisfactorily completed for the first phase of the project, the Owner shall be provided with operator instructions (including start-up, shut-down, emergency, maintenance, and repair instructions). Instruction shall be by the manufacturer's authorized service representative.

B. Time Period: Instruction period shall be for a minimum of three separate sessions of four hours each. Training to be provided to three Owner staff members.

C. Maintenance Tool Training: Provide training on maintenance tool for three separate four sessions over a two month period. In addition to classroom sessions, training shall be “hands-on” involving use of the tool on this project’s system and demonstrating trouble-shooting and trending procedures.

3.9 COMMISSIONING

A. The Products referenced in this section are to be commissioned per Section 20 08 00 - Commissioning. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications.

END OF SECTION 238127

SECTION 238246

ELECTRIC HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.

B. Requirements of Section 20 05 00 apply to this Section.

1.2 WORK INCLUDED

A. Electric Heaters.

1.3 SUBMITTALS

A. General: Comply with Section 20 05 00.

B. Product Data: Submit product information on all items.

1.4 GENERAL REQUIREMENTS

A. Listing: All heaters shall be listed by an independent testing laboratory for the application indicated.

B. Installation Verification: Prior to ordering units confirm finishes at heater location and type of installation and associated trim required; i.e. fully recessed, semi recessed, surface mount, etc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products: Shall comply with Section 20 05 00 Part 2.01 - Acceptable Manufacturers.

B. Duct Heaters: Indeeco, Berko, Markel, Q-Mark, Warren.

2.2 DUCT ELECTRIC HEATERS

A. Type: Open coil type electric duct heaters; of size and capacity as shown on the drawings.

B. Listing: Heaters shall be UL listed for zero clearance to combustibles, and shall be built to meet all requirements of the National Electric Code and NFPA.

C. Construction: Heating coils shall be made of 80% nickel and 20% chromium coiled resistance wire. Coils shall be supported in an aluminized steel frame and insulated by floating ceramic bushings. Heaters shall be of the configuration to suit the application as shown on the drawings.

D. Overtemperature Protection: All heaters shall be equipped with primary and secondary overtemperature safety devices. The primary safety device shall be a disc or liquid filled bulb type with automatic reset; the secondary device shall be a disc type with manual reset, wired in series with each heater stage, set to trip at a higher temperature than the primary safety device.

E. Overcurrent Protection: Fuses shall be provided for overcurrent protection; fuse capacities shall be rated for at least 125% of the circuit amperage.

F. Proof of Air Flow: Where project's control system is the DDC type, and heater is controlled by the DDC, proof of airflow is to be provided via the DDC system; no proof of airflow devices are required to be furnished integral with the heater. For non-DDC control systems or where the DDC control system is not providing heater control, provide heater with differential air pressure device and sensing tube (or sail flow switch), interlocked with the heater to prevent heater operation in case of insufficient airflow across the coil. Differential air pressure device (or sail flow switch) shall have sufficient sensitivity to suit velocity and duct pressures of the application. Configure and arrange differential air pressure device (or sail flow switch) for proper operation as the application requires. Air differential air pressure device shall have a pitot tube on high pressure side installed to sense duct total air pressure; except where heater is used on the suction side of a fan, the air differential air pressure device shall be connected to the low pressure side and be configured sensor to measure static pressure only. Where sensitive enough differential air pressure devices (or sail flow switches) are not available, provide heater with 24 volt relay for interlocking to a fan proof device (i.e. motor starter auxiliary contacts, fan start relay, or equivalent).

G. Terminal Box: All heater controls shall be mounted in a side mounted terminal box, unless a separate remote mounted terminal box is shown on the drawings. Terminal box shall be insulated from the heater casing.

H. Disconnect: Heaters shall be provided with a built-in power disconnect switch, having a terminal door interlock.

I. Controls: Heaters shall be furnished with 24 volt transformer and shall be for use with 24 volt controls unless indicated otherwise. Transformer shall have secondary fusing, and transformers which are not class 2 shall have primary fusing. Mercury control contactors shall be used for controlling heater stages unless indicated otherwise. Where SCR control has been indicated the heater shall be furnished with a solid state proportional power controller allowing modulation of heater capacity from 0 to 100% of full capacity. The SCR control shall energize the heater only for the number of AC cycles necessary to produce the amount of heat required. For heaters with loads greater than 90 amps SCR control combined with a step controller in a vernier configuration (still providing full proportional control) is acceptable. (Backup or safety contactors - where used - shall be magnetic type).

J. Electrical: Heaters shall be for use with electricity of the voltage and phase indicated, and provide the output and number of control stages indicated. Three phase heaters shall have equal balanced three phase circuits. Heater element circuits shall be subdivided so that no circuit load exceeds 48 amperes. All internal wiring shall be suitable for 220 degrees.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with Section 20 05 00. Install in accordance with manufacturer's written instructions, code, applicable standards and best construction practices.

B. Coordination: Coordinate heater power and control requirements with other trades; confirm location of any required heater contactors, relays, thermostats, and similar devices. Provide any required wiring for proof of fan operation between fan devices and heater; wiring shall comply with the HVAC control portion of the specifications and Division 26.

C. Location and Trim Verification: Install equipment at locations indicated in accordance with the Contract Documents. Review and confirm installation locations, that proper clearances are provided, unit controls are accessible, and installation has been coordinated with other trades.

D. Complete Connections: Connect and install all items shipped loose with units; provide and connect all contactors, relays, wiring, interconnections and accessories as required for proper unit operation.

E. Cleaning: Units shall be thoroughly cleaned (internally and externally) of all debris prior to operation. Units shall be clean and in new condition prior to Owner acceptance.

F. Owner Instruction: Instruct Owner on equipment operation and maintenance.

3.2 START-UP

A. Pre Start-Up Inspection: Inspect equipment and connecting systems to confirm equipment and connecting systems to confirm equipment has been installed properly and is ready for start-up. As a minimum, check for: proper voltage and phases, correct electrical connections, complete control connections, all unit safety devices properly set and connected, coils clear of obstructions, and other items as listed by the manufacturer are properly provided/connected and operating to ensure safe and proper start-up. If items are discovered that prevent start-up to be completed, notify the installing Contractor and Engineer of issues. Coordinate and re-schedule start-up after items are corrected.

B. Start-Up: Perform start-up in accordance with manufacturers written start-up procedures. Observe proper operation of all unit components.

C. Adjustments: Adjust and set unit components to allow for proper operation. Observe unit to detect any unusual vibration, leakage, loose wiring, or other situations that could affect unit operation.

END OF SECTION 238246

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of electrical work. This section applies to all Divisions 26, 27, and 28 sections.

B. General Requirements: General Conditions, Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 CODES AND STANDARDS

A. Perform work in accordance with requirements of the state in which the work is performed.

B. Conform to applicable industry standards, UL standards, NEMA standards, and other standards as noted.

1. Notify the A/E of deviations in Contract Documents to applicable codes and ordinances prior to installation of the Work. Perform changes in the Work after initial installation due to requirements of code enforcing agencies at no additional cost to the Owner.
2. If conflict occurs between legally adopted codes and the Contract Documents, the codes prevail. Contractor to comply with requirements of the Contract Documents which may exceed code requirements and not contrary to same.

C. Operating Conditions:

1. Temperature: Minus 20 deg C to plus 40 deg C.
2. Altitude: Up to 3,300 feet (1,000 meters).

1.03 PERMIT INFORMATION

A. Permit Application: Arrange for and pay for all required permits, fees, and inspections required for work included in Division 26, 27, and 28.

B. Permit Submittal Plan Review: Submit the following to the AHJ as required to support the permit application:

1. Electrical Permit: Submit bid documents
2. Fire Alarm Permit: Submit Shop drawings

C. Approved Permit Plans Printing: Print and have available for the inspector a full size color set of the approved plan review drawings. A digital set of approved drawings will be provided electronically and will be the same size and sheet count as the Bid Documents.

1.04 SUBMITTALS

A. Comply with requirements in Division 01 and with additional requirements indicated in this article.

B. Electronic Product Data:

1. Comply with requirements in Section 013300 and additional requirements indicated in this article.
2. Submit each specification section complete at one time with a dedicated submittal number for each section. For example, submit products for Section 260519 under one submittal number and products for Section 260533 under a different submittal number. Submitting multiple sections at one time acceptable as long as each section has a dedicated submittal number. Include submittal number and date submitted in file name.
3. Submit one hard copy of product data.

4. Submit signed letter indicating 3D model coordination has started and will continue through construction. 3D model not required to be submitted/reviewed during construction phase.
5. Partial product submittals not acceptable and will be returned without review except as follows:
    a. Section 260923 Lighting Controls including products and materials for first submittal and Shop Drawings for second submittal.
    b. Section 265100 Lighting including products and materials for first submittal and Shop Drawings for second submittal.
    c. Section 283111 Fire Alarm and Detection Systems including products and materials for first submittal and Shop Drawings for second submittal.
    d. Long lead items.
    e. Site and underground work.
6. Clearly mark catalog pages, equipment, and model number to be used. Indicate associated specification section and paragraph number on each page. Identify required options and accessories.
7. Format:
    a. Adobe PDF file format.
    b. Bookmark each submittal to facilitate browsing to each specification paragraph number.
    c. Include table of contents for each specification section. Include catalog numbers or drawing numbers.
    d. Include the Contractor and manufacturer's representative contact information for each product. Include job name (or abbreviation of job name), specification number, and contractor submittal number in file name.

C. Shop Drawings:
1. Submit as specified in the individual specification sections. Submit minimum 30 days prior to starting fabrication on installation work. Do not fabricate on install until reviewed by the A/E. Include complete location dimensions, and hanger and support sizes and dimensions.
2. "Typical" drawings and wiring diagrams not accepted unless they specifically apply to this project.
3. Provide drawings at sufficient scale to show details clearly on same size sheets as Drawings.
4. Show required coordination with work of other trades.
5. Identify details and show their locations in Project.
6. Include description of configuration and operation of proposed systems.
7. Include outline drawings of proposed equipment in plan and elevation views including overall dimensions, weights, and clearance required.
8. Include one-line electrical diagrams required for control and sensing.
9. Request floor plan backgrounds in electronic format from the A/E.
10. Direct use of the Drawings as the basis of Contractor's prepared Shop Drawings not acceptable.
11. Format:
    a. Adobe PDF file format.

D. Approval: Approval of a manufacturer's name or product by the A/E does not relieve the Contractor of the responsibility for providing materials and equipment which comply in detail with requirements of the Contract Documents.

E. As-Built Drawings: Daily updates and markups that reflect all changes made in the specifications and working drawings during the construction process, and show the exact dimensions, geometry, and location of all elements of the work completed under the contract.

F. Re-Submittals: Clearly identify re-submittals. Provide revised tabs, indexes, page renumbering, and other formats to interface with original submittal. Identify changes and include date for project tracking.

G. Test reports and Certificates: Submit as a package prior to Substantial Completion.

H. Certifications: Submit written certifications from the governing building authorities stating that work has been inspected and accepted, and complies with applicable codes and ordinances.

I. Record Drawings: Conformed set of as-builts developed during the construction process. Provide a single digital copy for each sheet in the contract documents and developed at the end of the construction phase. Comply with Article “Record Drawings” in this section.

J. Schedule of Values:
   1. Comply with the requirements in Division 01 with additional requirements as indicated in this paragraph.
   2. Include costs in Schedule of Values as follows:
      a. Mobilization.
      b. Submittals.
      c. Electrical Permit.
      d. 3D Coordination
      e. Lighting Systems – Fixtures & Lamps Material.
      f. Lighting Systems – Fixtures & Lamps Labor.
      g. Lighting Systems – Branch Circuit Raceway Rough-in, Material.
      h. Lighting Systems – Branch Circuit Raceway Rough-in, Labor.
      i. Lighting Systems – Branch Circuit Wiring, Material.
      j. Lighting Systems – Branch Circuit Wiring Labor.
      k. Lighting Systems – Devices & Trim, Material.
      l. Lighting Systems – Devices & Trim, Labor.
      m. Power Systems – Equipment Connections.
      n. Power Systems – Branch Circuit Raceway Rough-in, Material.
      o. Power Systems – Branch Circuit Raceway Rough-in, Labor.
      p. Power Systems – Branch Circuit Wiring, Material.
      q. Power Systems – Branch Circuit Wiring, Labor.
      r. Power Systems – Devices & Trim, Material.
      s. Power Systems – Devices & Trim, Labor.
      t. Low Voltage – Fire Alarm Rough-in, Material.
      u. Low Voltage – Fire Alarm Rough-in, Labor.
      v. Low Voltage – Fire Alarm Trim, Material.
      w. Low Voltage – Fire Alarm Trim, Labor.
      x. Low Voltage – Telecommunications Pathway Rough-in, Material.
      y. Low Voltage – Telecommunications Pathway Rough-in, Labor.
      z. Low Voltage – Telecommunications Cabling, Material.
      aa. Low Voltage – Telecommunications Cabling, Labor.
      bb. Low Voltage – Access Control, Material.
      cc. Low Voltage – Access Control, Labor.

dd. Low Voltage – Security Video, Material.
ee. Low Voltage – Security Video, Labor.
ff. Punch List and Close Out.
gg. Testing Commissioning and Training.

1.05 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division 01 for definitions and abbreviations. Additional definitions and abbreviations are as follows.

B. “Approved” or “Approval” means written approval by the owner or “Owner’s agent” (A/E).

C. “Codes” means AHJ adopted codes, rules, and ordinances and additional codes as specified herein.

D. “Concealed” means spaces out of sight. For example, above ceilings, below floors, between double walls, furred-in areas, pipe and duct shafts, and similar spaces.

E. The word “Contractor”, as used in Divisions 26, 27, and 28 sections, means the electrical subcontractor.

F. “Coordination”, “Coordinating”, and “Coordinate” means to bring, or the bringing, into a common action, movement, or combination so as to act together in a smooth concerted way.

G. “Demolition”, “Demo”, “Demolish” means to disconnect, remove and properly dispose of existing devices, components, equipment.

H. “Directed”, “Requested”, “Accepted”, and Similar Terms means these terms imply “by the A/E” unless otherwise indicated.

I. “Exposed” means open to view. For example, raceways installed in a tunnel or raceways installed in a room and not covered by other construction.

J. “Furnish” means supply and deliver to the project site ready for unloading, unpacking, assembly, installation, and similar activities.

K. “Indicated” and “Indicated on the Drawings” means shown on Drawings by notes, graphics or schedules, or written into other portions of Contract Documents. Terms such as “shown”, “noted”, “scheduled” and “specified” have same meanings as “indicated”, and are used to assist the reader in locating particular information.

L. “Install” means to place in position for service or use. Includes operations at project site, such as unloading, unpacking, assembly, erection, placing, preserving, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar activities.

M. “Provide” means furnish and install for a complete, finished, and operable system and ready for intended use.

N. “Shop Drawings” means Document which fully details equipment and intended installation relative to this specific Project.

O. “Structural Members” means all above and below grade elements associated with the structural support of the building or structure.

P. “Substantial Completion” means that the entire project (or readily definable portion thereof if so designated in the Contracted Documents) is acceptable to code enforcement authorities and to extent required by such authorities, has been inspected and approved by such authorities, and is suitable for occupancy by the Owner or occupant for the purpose intended. Refer to Divisions 00 and 01 for additional requirements.

Q. “Work” or “Project” means entire scope of work required by the Contract Documents.

R. Abbreviations:

A/E	Architect
ADS	Acoustical Distinguishable Space
AFCI	Arc Fault Circuit Interrupter
AHJ	Authorities Having Jurisdiction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATP	Acceptance Test Procedure
BMS	Building Management System
BOM	Bill-of-Material
C	Degrees Celsius
CEC	Canadian Electrical Code
CCT	Correlated Color Temperature
CIS	Common Intelligibility Scale
CSA	Canadian Standards Association
CR	Controlled Receptacle
CRI	Color Rendering Index
CU	Coefficient of Utilization
DAS	Distributed Antenna System
EBS	Educational Broadband Service
EMS	Energy Management System
EMT	Electrical Metallic Tubing
EPO	Emergency Power Off
ETL	Environmental Technology Laboratory
EUSERC	Electric Utility Service Equipment Requirements
F	Degrees Fahrenheit
FC	Foot-candle
FM	Factory Mutual Engineering Corporation
GB	Ground Fault Circuit Interrupter Breaker
GFCI	Ground Fault Circuit Interrupter
GFI	Ground Fault Circuit Interrupter
GUI	Graphical User Interface
HDPE	High-density polyethylene
HID	High-intensity discharge
HVAC	Heating, Ventilation and Air Conditioning
IC	Insulation contact
IBC	International Building Code
IDF	Intermediate distribution frame
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMC	Intermediate Metal Conduit
K	Kelvin
kVA	Kilo Volt Amps
LED	Light-emitting diode
LPI	Lightning Protection Institute
MC	Metal Clad
MDF	Main distribution frame
NEC	National Electrical Code, NFPA 70 (latest adopted edition with Amendments)
NEMA	National Electrical Manufacturer's Association
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Test Laboratory
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl

PDU	Power Distribution Units
PF	Power factor
RMC	Rigid Metal Conduit
RMS	Root Mean Square
RTRC	Reinforced thermosetting resin conduit
SCCR	Short Circuit Current Rating
SPD	Surge Protective Devices
STC	Factory Standard Test Condition
STI	Sound transmission index
STIPA	STI for public address systems
TCLP	Toxicity characteristic leaching procedure
THD	Total Harmonic Distortion
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories Inc.
UPS	Uninterruptible Power Supply
V	Volts
VOIP	Voice Over Internet Protocol
VRLA	Valve Regulated Lead Acid Batteries

1.06 MATERIALS

A. Where two or more manufacturers are listed, select for use any of those listed. The first mentioned, in general, was used as the basis of design. Bids on any manufacturer named acceptable as long as that manufacturer meets every aspect of the Contract Documents. Note that equipment layout is based on equipment listed in equipment schedules.

B. Ensure that equipment will fit within available space. Where other than basis of design manufacturer is selected for the Project, the Contractor is responsible for verifying equipment will fit within available space and meet manufacturer's and code required clearances.

C. Where other than basis of design manufacturer is selected for the Project, include cost of resulting additional work, coordination with other trades, and redesign of associated building services and structure as required to accommodate selected equipment. Include redesign drawings with submitted Shop Drawings.

D. Include costs in base bid for required redesign work by A/E to accommodate proposed Product. The Owner will compensate Engineer through the A/E at rate of $150.00 per hour for time and expense for required review of submittals and additional coordination for redesign work. Amount of compensation will be deducted from Final Payment to the Contractor.

1.07 STANDARDS OF QUALITY

A. Materials and Equipment: UL listed and labeled or other AHJ approved testing laboratory and in compliance with other industry standards as specified.

B. Provide manufacture's regularly catalogued items and supply as a complete unit in accordance with manufacturer's standard specifications and any optional items required for proper installation for equipment unless otherwise noted. Install equipment and materials in accordance with the manufacturer's recommendations and best trade practices.

C. Provide new products unless indicated otherwise in the Contract Documents.

D. Fabricator and Manufacturer Qualifications: Specialists with at least 5 years' experience and regularly engaged in manufacture of equipment and materials specified.

E. Furnish products of a single manufacturer for items which are used in quantity. A Product, for the purpose of this paragraph, is an assembly of components such as switchboards, transformers, panelboards, and similar items. Materials such as wire and cable, raceways, outlet boxes, and similar items not requiring maintenance are not included in the single manufacturer requirement of this paragraph.

F. Installer Qualifications: Specialists with at least 5 years' experience and regularly engaged in the installation of the system, equipment, and materials specified. Where required by the AHJ, employ licensed trades persons.

1.08 SUBSTITUTIONS

A. Comply with requirements in Division 01 with additional requirements indicated in this article.

B. Substitutions will be considered following bid award only when a product becomes unavailable through no fault of the Contractor.

C. Where "Manufacturer" paragraphs include the words "or approved", prior approval of the proposed substitution is required. The A/E is sole judge of quality of proposed substitution.

D. When the A/E approves a substitution request, the approval is given with the understanding that the Bidder:

1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
2. Will provide the same warranty for the Substitution as for the specified Product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.

E. Whenever a Product is described by detail, specification, trade name, manufacturer's name or catalog reference, use only such Product, unless written approval is given for substitution prior to bid. Submit written requests on substitution request form included in Division 01. Approved substituted manufacturers will be listed by Addendum. There are no prior approvals for this project.

F. Provide as specified certain products, materials, and systems where "manufacturer" paragraphs are followed by the words "no substitutions".

G. Substitutions will not be considered when they are indicated or implied on Shop Drawings or product data submittals, without separate written prior approval, or when approval will require revision to the Contract Documents.

1.09 DRAWINGS AND SPECIFICATIONS

A. General: The electrical drawings are diagrammatic. Complete details of building features which affect electrical installation may not be shown. For additional details, refer to other Contract Documents. Report any discrepancies to the A/E along with suggested revisions. Obtain written response from the A/E before proceeding with changes.

B. Depiction of Work: Drawings do not show the exact characteristics of the work including, physical arrangement of equipment, lengths of wiring or conduit runs. Base work on actual field measurements and conditions. Provide work required to complete the installation.

C. Dimensions: Do not scale drawings. Dimensional accuracy is not guaranteed, and field verification of dimensions, locations, and levels to suit field conditions is required.

D. Since the Drawings of floor, wall, and ceiling installation are made at small scale, outlets, devices, equipment, and similar items are indicated only in their approximate location. Locate outlets and apparatus symmetrically on floors, walls, and ceilings where not dimensioned and coordinate such locations with work of other trades to prevent interferences.

E. Discrepancies: Field verify dimensions and existing conditions prior to performing work. Bring to the A/E's attention any discrepancies within the Contract Documents and between the Contract Documents and field conditions. Also for any design and layout changes required due to specific equipment selection, prior to the Contractor's work (equipment and material purchasing and installation). Provide corrective work required after discovery of such discrepancies, inconsistencies, or ambiguities at no additional cost to the Owner.

F. Specifications: These specifications are written in imperative mood and streamlined form. The imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.10 RECORD DRAWINGS

A. Comply with requirements in Division 01, with additional requirements as indicated in this article.

B. Prepare As-Built drawings: Red line As-Built Drawing prints in digital or hand drawn format (pencil and black pen not acceptable). Include:

1. Corrections and Changes: Record during the progress of the Work, showing work as actually installed.
    a. Show the measured locations of portions of the Work and changes the Contractor has made.
    b. In general, tolerance plus or minus 1'-0" from actual location.
    c. Show addendum items, change orders, clarifications, supplemental instructions, and deviations from the Drawings. Show device or equipment changes and indicate where the change was originated. Only indicating the document where the change originated from will not be accepted.
2. Updates: Neatly hand-draft on daily basis and kept readily available at project site. Updates are subject to review by the A/E on a regular basis throughout construction. Updates are to include the following at a minimum:
    a. Feeder routing indicating upstream and downstream equipment.
    b. Installation locations for underground raceways and where they transition to above grade.
    c. Device locations and mounting heights.
    d. Junction and pull boxes with two or more home runs.
    e. Junction and pull boxes with one home run.
    f. Circuit information.
    g. Shop Drawings: Update shop drawings with changes or deviations from the Original Shop Drawings. Provide updates to manufacturer/vendor for inclusion in Record Drawings.

C. Record Drawings: Develop a digital set of Record Drawings for the project utilizing the as-built drawings. Digital Record Drawings can be in AutoCAD or PDF format. At end of construction, check drawings for completeness and accuracy.

D. Shop Drawing Record Drawings: Provide updated shop drawings based on As-Built drawings for use as Record Drawings.

E. Per project closeout procedures, submit in Digital Record Drawings and a copy of the As-Builts. Note each sheet as “RECORD DRAWING”.

F. 3D Coordination Model: Include fully coordinated 3D model.

1.11 COORDINATION

A. Coordinate Divisions 26, 27, and 28 work with other trades.

B. Develop 3D model for coordination with other trades.
   1. Format: 3D drawings using industry recognized software that is compatible with general contractor’s 3D software.
   2. Include electrical conduits, cable trays, electrical equipment, lighting fixtures and other items to be installed in ceilings, full height walls, and other items necessary to coordinate installation.
   3. Attend coordination meetings and make modifications to the 3D model until all items have been coordinated.

C. Be aware of restricted space for installation of electrical systems. Include offsets and perform rerouting and coordination to fit elements in available space. Include provisions for such requirements in bid.

D. Electrical equipment and systems shown are based on existing drawings as available and on limited project site observations to the extent possible under current conditions. Field verify existing conditions prior to commencement of work. Obtain specific locations of structural and architectural features or equipment items from referenced drawings, field measurements, or trade providing material or equipment.

E. Coordinate raceway installations to clear light fixtures and electrical cable trays. Include clearance over light fixtures to allow removal and replacement. Include minimum 6 inch clearance above and to sides of cable trays.

F. Existing Conditions:
   1. General Construction:
      a. Installation of electrical, telecommunications, and electronic safety and security work will require openings, removal and replacement of ceilings, sleeves, and restoration of general construction to match existing. Some work occurs in areas not requiring alterations as part of architectural work. Coordinate new openings and restoration work so that there is no additional cost to the Owner.
      b. General construction work shown on the architectural drawings may require removal, relocation, and reinstallation of existing electrical, telecommunications, electronic safety and security work. Since existing conditions cannot be completely detailed on the Drawings, survey the site and perform required Work at no additional cost to the Owner.
   2. This project may require work in the presence of asbestos containing material (ACM). Division 26 does not provide for or cover the identification, removal, incapsulation, or disposal of such material. If the presence of ACM is suspected, notify the Owner prior to proceeding with in the vicinity of ACM.

G. Be responsible for beam penetrations as they relate to the electrical work. Submit sizes and locations to the structural engineer for review and determination of structural details.

H. Coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed.

I. Refer to architectural and structural drawings for location of expansion and seismic joints. Provide flexible loops for raceways and cable trays crossing expansion and seismic joints.

1.12 WORKMANSHIP

A. Provide work in accordance with best trade practices. Remove substandard workmanship and provide new material at no extra cost to the Owner.

1.13 SITE VISIT

A. Visit site during bidding period to note conditions affecting installation of Work. No additional charges allowed due to failure to adequately review conditions.

B. Investigate each space through which equipment must be moved. Where necessary, arrange with equipment manufacturers to ship equipment in sections with suitable dimensions for moving through restricted spaces. For movement through occupied spaces, ascertain from the Owner as acceptable times of day or night that movement could occur. Include costs in bid for off hours labor, reassembly, and field testing.

1.14 CERTIFICATION

A. By submitting a bid for the electrical, telecommunications, electronic safety and security systems, the Contractor and his subcontractors acknowledge and certify the following:

1. That they have carefully examined and fully understand the Drawings and Specifications (including but not limited to architectural, site, utility, mechanical, structural and electrical drawings and specifications. In addition, they have determined that the Drawings and Specifications are adequate to complete the electrical systems and that they can provide a complete finished and operable system in accordance with the Contract Documents.
2. That they have had a reasonable opportunity to discover any ambiguities in the Contract Documents and such ambiguities have been brought to the attention of the A/E in writing prior to submitting the bid.
3. That they have reviewed the project progress schedule with the general contractor, fully understand the schedule, and they have verified, prior to submitting a bid, availability of necessary labor and materials, including supervision and office backup, and can comply with the schedule requirements.
4. That there may be changes to the scope of work and that they understand that any proposal submitted for performance of additional work includes costs associated with such change including but not limited to labor, materials, subcontracts, equipment, taxes, fees, schedule impact, loss of efficiency, supervision, overhead and profit.
5. That the Contract requires them to coordinate their work with that of other trades and that responsibility for coordination includes rerouting, offsets, and similar provisions, to fit Work and address manufacturer’s recommended clearances for service access, maintenance, and replacement of equipment in a manner that is compatible with work of other trades in the same area.
6. That routing of elements of electrical systems shown on the Drawings is schematic only and that offsets and rerouting probably will be required in installation and that labor and materials have been included for such in their bids.
7. That they understand submittals of material and equipment to the A/E is for the purpose of establishing what they are providing for the project. Any review undertaken by the A/E does not relieve them of their responsibilities to furnish and install materials and equipment required for work in the project nor does such review relieve them of their responsibilities for coordination with other trades and designers to ensure that such materials and equipment will fit and be suitable for purpose intended.
8. That they agree to receive payment for bid amounts as full compensation for furnishing materials and labor which may be required in prosecution and completion of work required under the Contract Documents, and in respects to complete the contract work to the satisfaction of the A/E.

9. That they include in their bids costs to furnish bonds as specified in the Contract Documents.

1.15 WARRANTY

A. Conform to requirements in General Conditions, Supplementary Conditions, and Division 01. Where not so prescribed or defined, provide for a period of 1 year.

B. Warranty periods within Divisions 26, 27, and 28 are based on industry standard warranty periods and commence on the Substantial Completion date. Provide extended factory warranties as required to account for the difference between standard factory warranty start time and date of the Substantial Completion.

1.16 EQUIPMENT FURNISHED BY OWNER INSTALLED BY CONTRACTOR (FOIC)

A. Material Handling and Delivery: Coordinate delivery of FOIC equipment. Receive, off load, transport, store, hoist, unpack, dispose of packing, same as for other project equipment arriving at job site. Requirements of the Contract Documents apply to FOIC equipment.

B. Operation and Maintenance Data: Obtain from the Owner operation and maintenance data for the FOIC equipment and incorporate them into the Operations and Maintenance Manuals.

C. Start-up and Warranty:

1. FOIC equipment suppliers will pass on to the Contractor start-up information, maintenance and parts information, and warranty provisions of their products in accordance with the equipment suppliers contract requirements. Organize and coordinate start-up and warranty requirements for the FOIC equipment.
2. Include one year warranty on FOIC equipment starting at Substantial Completion regardless of shorter time limits by FOIC suppliers.

1.17 DEMONSTRATION

A. Comply with requirements in Division 01 with additional requirements indicated in this article.

B. Following installation of electrical work and prior to final acceptance, demonstrate that equipment and systems operate as indicated in the Contract Documents and in accordance with manufacturer’s recommendations.

C. Perform in presence of the A/E and Owner’s representative, unless otherwise directed by the A/E. Give minimum 1 week notice prior to demonstrations.

D. Provide instruments and personnel required to conduct demonstrations.

1.18 SUBSTANTIAL COMPLETION

A. Comply with requirements in Division 01.

B. Prepare list of items that are not complete prior to asking for a substantial completion review by the A/E.

1.19 ALTERNATES

A. General: See Bid Form and Alternates described in Division 01 for possible effect on work of Divisions 26, 27, and 28.

1.20 CONTINUITY OF EXISTING UTILITY SERVICES

A. Shutdown Duration: Comply with requirements in Division 01. Perform work without shutdown of more than 4 hour duration of existing systems. Schedule each shutdown in writing with the Owner at least 7 days in advance of shutdown and obtain advance written approval from the Owner.

B. Temporary Services: Provide during necessary interruptions of existing utilities.

C. Owner Occupancy:
   1. Perform work in the existing building with respect for the necessity of the Owner's employees to perform their regular work.
   2. Plan installation of new work and connections to existing work to assure minimum interference with regular operation of existing facilities. Do not remove, disconnect, or shutdown systems without prior review by the Owner to confirm that areas needed to remain in operation are not affected.
   3. Provide temporary, wiring, lighting, and similar systems and connect to existing systems to keep existing electrical systems in operation to service areas that need to remain occupied.

1.21 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals for equipment and materials furnished under Divisions 26, 27, and 28.

B. Comply with requirements in Division 01 with additional requirements indicated in this article.

C. Submit one hard copy and one electronic PDF format of Operation and Maintenance Manuals for review at least 4 weeks prior to Substantial Completion date. Assemble hard copy Operation and Maintenance Manual in 3-ring binder(s). Use multiple binders if pages in a single binder would exceed 4 inch thickness. Separate binders for each category, such as Electrical, Telecommunications, and Electronic Safety and Security. Where one subject matter encompasses more than one binder, differentiate by volume numbers. Include indexed tabs for each binder. Engrave cover with the project title in 1/2 inch high letters and name and address of the Contractor in 1/4 inch high letters. Provide same information in 1/8 inch high letters on spine.

D. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Include serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, and similar information. Provide individual sheet for each item of equipment. (Example: If 2 items of equipment A and D appear on the same sheet, provide individual sheet for each unit specified.)

E. Include the Following Information:
   1. Identifying name and mark number.
   2. Certified outline drawings and Shop Drawings.
   3. Parts list.
   4. Performance curves and data.
   5. Wiring diagrams.
   6. Manufacturer's recommended operating and maintenance instructions.
   7. Vendor's name, address and telephone number for all parts and equipment.
   8. Name, address and telephone number of Contractor performing the work.
   9. Test reports.
   10. Product data and Record Drawings.

1.22 TESTING

A. Comply with requirements in Section 260810.

1.23 PROJECT TRAINING

A. Upon completion and testing of equipment and system installation, assemble equipment factory representatives and subcontractors for system training with Owner's representatives as required in specific specification sections.

B. Provide representative and subcontractor assistance in start-up, check out, and training for their respective system and remain on-site until the total system operation is thoroughly reviewed by the Owner's representatives and are thoroughly trained. Return for additional training sessions as required to completely train Owner's Representatives.

C. Provide factory representative and system subcontractor personal instruction on operating and maintenance of their equipment to the Owner's maintenance and operation personnel. To certify acceptance of operation and instruction by the Owner's representative, prepare a written statement as follows:

1. This is to certify that the factory representative and system subcontractor for each system listed below have performed start-up and final check out of their respective systems.
2. The Owner's maintenance and operation personnel have received complete and thorough instruction in the operation and maintenance of each system.

SYSTEM	FACTORY REPRESENTATIVE
(List systems included)	(List name and address of factory representative).
_____	_____
Owner's Representative	Contractor

D. Submit copy of acceptance to A/E.

1.24 PUNCHLIST AND FINAL REVIEWS

A. Provide electrical foreman assistance at the time of punchlist and final reviews and accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested to allow review of entire electrical system.

B. Punch List: Review each punch list item; update field conditions to address items or provide comment response for reason the item has not been addressed in the field.

1.25 PROJECT CLOSEOUT

A. Include costs of engineering services required beyond the final completion date paid by the Contractor at a rate of $150 per hour.

B. Punchlists by A/E at Substantial Completion and final completion dates. Submit Record Drawings and final Operation and Maintenance Manuals prior to Substantial Completion date. Subsequent reviews paid by the Contractor at a rate of $150 per hour.

1.26 COMMISSIONING SUPPORT

A. Comply with requirements in Sections 019113 and 260810.

B. Division 26 subcontractor: assist in developing final Functional Test Procedures as specified in Sections 019113 and 260810.

C. Start-up and testing services and Functional Performance Testing provided by equipment manufacturer’s authorized representatives as specified in Sections 019113 and 260810.

D. Submit equipment start-up and test procedures and preliminary Operation and Maintenance Manuals to the Commissioning Authority. Submit under separate bound cover.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes basic electrical requirements specifically applicable to Divisions 26, 27, and 28 sections including general material and installation requirements and site work.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. UL Compliance: Where UL fire-resistance rating is indicated for construction penetrated by access units, furnish UL listed and labeled units, except for those units which are smaller than minimum size requiring ratings as recognized by governing authority.

C. Codes and Standards:

1. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods to prevent damage, deterioration, and loss, including theft.

B. Deliver products to site in manufacturer's original containers, complete with labels.

C. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

D. Store products subject to damage by weather conditions above ground, under cover in weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish specified items acceptable to AHJ as suitable for intended use.

B. New, unless otherwise indicated, free from defects and the standard products of reputable manufacturers regularly engaged in production of such equipment.

C. Furnish similar items of equipment by same manufacturer.

D. Materials and Equipment: UL listed and labeled or other AHJ approved testing laboratory and in compliance with other industry standards as specified.

E. Remove rejected or damaged material from site.

F. Samples may be required for non-standard or substituted items before installation. Submit samples as required in specific specification sections.

G. Furnish required items necessary for installation and testing procedures.

2.02 POSTED INSTRUCTIONS

A. Posted Operating Instructions: Furnish simplified, consolidated equipment control and power diagrams. Graphically represent entire system and actual equipment installed. Include concise written instructions on how to start and stop systems. Show settings and conditions to be observed. Indicate what control adjustments are to be made or maintained by the operator.
   1. Include control diagrams and specific operating instructions.
   2. Indicate how to energize each major component of systems. Show what action must be taken in an emergency, how to restore power following an outage, and what precautions to be taken when maintenance is required.
   3. Include photographic or comparable non-fading reproductions, either framed under glass or encased in non-discoloring plastic.
   4. Include one-line diagrams of electric power distribution riser.

B. Copies of operating instructions shall be used with Operation and Maintenance Manuals as basis in training Owner's employees in the operation and maintenance of systems and related installed equipment.

2.03 ENCLOSURES

A. NEMA Type 1 – Dry Interior locations unless otherwise noted on drawings or as specified below.

B. NEMA 3R Weather-proof/Rain-proof – Windblown rain, sleet, ice – Provide in all locations where exposed to moisture unless otherwise noted.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify installation conditions as satisfactory to receive work of the various sections. Do not install until unsatisfactory conditions are corrected.

3.02 INSPECTIONS

A. Confirm that installations have been inspected before enclosure within building features, buried, or otherwise hidden from view. Pay costs associated with uncovering or exposing installations and features not previously inspected and for repair to exposed surfaces.

3.03 PREPARATION

A. Protect surrounding areas and surfaces to prevent damage as work is installed.

B. Obtain equipment roughing-in dimensions from approved Shop Drawings or actual measurements.

C. Be familiar with the location of other trade's equipment. Eliminate conflicts. Check door swings before installing switches. Locate switches on strike side of doors unless noted otherwise.

D. Layout electrical, telecommunications, and electronic safety and security work in advance of construction to eliminate unnecessary cutting, drilling, channeling, and similar activities. Where such cutting, drilling, channeling and similar activities become necessary for proper installation, perform with care using skilled mechanics of trades involved. Repair damage to building and equipment at no additional cost to the Owner.

E. Perform cutting work of other trades only with consent of that trade. Cutting structural members not permitted without consent of the A/E.

3.04 INSTALLATION

A. Install Work as specified and in accordance with the Drawings and manufacturer's instructions. Where these conflict, manufacturer's instructions govern.

B. Review Architectural, Mechanical and other applicable drawings and applicable Shop Drawings to prevent switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, and similar items, or from being located in whiteboards, tackboards, glass panels, and similar items. Relocate electrical devices and connections as directed by the A/E at no additional cost to the Owner if the work is not properly coordinated.

C. Where conduit, outlets, and apparatus are encased in concrete, locate and secure at point of installation. Check locations of electrical items before and after concrete and masonry installation and relocate displaced items.

D. Provide block-outs, sleeves, demolition work, and similar items required for installation of Work specified in this division.

3.05 WORKMANSHIP

A. Work and materials will be subject to observation at any time by the Owner and the A/E.

B. Install material and equipment in accordance with manufacturer's instructions. Provide calibrated torque wrenches and screwdrivers as required.

C. Cutting and Patching: Do not weld to, cut, or notch structural members or building surfaces without approval of the A/E. Restore surfaces neatly to original condition after cutting, channeling, chasing, and drilling of walls, partitions, ceilings, paving, and anchorage of conduit, raceways, and other electrical equipment.

3.06 WELDING, CUTTING, AND DRILLING

A. Perform in accordance with American Welding Society Standards.

3.07 CLEANING

A. Clean equipment, conduit, and fittings and remove packing cartons and other debris created by Divisions 26, 27, and 28 Work.

B. Before Substantial Completion, carefully clean equipment, fixtures, exposed raceways and similar items. Remove construction labels, dirt, cuttings, paint, plaster, mortar, concrete, and similar items. Clean fixtures, interiors and exteriors of equipment and raceways.

3.08 IDENTIFICATION

A. Provide nameplates and decals required to identify equipment and components, comply with requirements in Section 260553.

B. Mount operating instructions and diagrams near equipment or elsewhere as otherwise designated by the Owner.

3.09 PROTECTION

A. Protect equipment during and after electrical hookup, painting, and final testing.

3.10 REMOVAL AND REPLACEMENT OF EXISTING ACCESSIBLE CEILING PANELS

A. General: Remove and reinstall necessary panels in existing accessible ceilings to install electrical work in areas where no architectural work is being performed. Where existing ceiling panels are damaged, replace with new to match existing. After ceiling removal and reinstallation is complete, ceiling system appearance shall match adjacent similar ceilings that have not been removed.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes final electrical connection to equipment having electrical requirements. Contractor shall make final connections for Owner furnished equipment including switches, receptacles, and similar items. See other applicable specification sections for building temperature control wiring requirements specified in Divisions 21, 22, and 23.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

C. Connection to Equipment Specified in Divisions 21, 22, and 23 as Follows unless Specified Otherwise in Divisions 21, 22, and 23:

1. For motorized only equipment with built-in controllers (packaged equipment), Connect power and provide an external disconnect at equipment. Division 23 will provide control wiring.
2. For motorized only equipment with external controller (non-packaged equipment), provide external motor controller, disconnect switch, and make power wiring complete to equipment. Division 23 will provide control wiring.
3. For electric duct heaters with built-in controllers (packaged type equipment), connect power complete and provide external disconnect switch at equipment. Division 23 will provide control wiring.
4. For electric duct heaters with remote controllers (non-packaged type equipment), provide external controller, disconnect switch, and make power wiring to equipment. Division 23 will provide control wiring.
5. For combination motorized and electric heating packaged units specified with built in controllers and specified with “single point electrical connection” under Division 23, connect power and provide external disconnect switch. Division 23 will provide control wiring.
6. For equipment requiring a full voltage non-reversing starter, include as a combination disconnect unit.

D. Refer to Division 23 sections for control system wiring.

E. Refer to sections of other divisions for specific individual equipment power requirements.

F. Make final connection to kitchen equipment.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.

C. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements and to applicable Division 26 sections.

D. UL Labels: Provide electrical connection products and materials which have been UL listed and labeled.

PART 2 PRODUCTS

2.01 ELECTRICAL CONNECTIONS MATERIALS

A. For each electrical connection indicated, include complete assembly of materials, including but not limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories to complete splices, terminations, and connections.

B. Comply with requirements in Section 260519 for wires and cables, Section 260533 for raceway systems, and Section 262726 for wiring devices.

C. Include Final Connections for Equipment Consistent with the Following:
   1. Permanently Installed Fixed Equipment: Flexible seal-tite conduit from branch circuit terminal equipment, and raceway to equipment, control cabinet, terminal junction box, and wiring terminals. Totally enclose wiring in raceway.
   2. Movable and/or Portable Equipment: Wiring device, cord cap, and multi-conductor cord suitable for equipment and in accordance with NEC requirements.
   3. Other methods as required by NEC and as required by special equipment and field conditions.

PART 3 EXECUTION

3.01 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.

C. Coordinate installation of electrical connections for equipment with installed equipment.

D. Verify electrical loads (voltage, phase, full load amperes, number and point of connections, minimum circuit ampacity, and similar characteristics) for equipment furnished under other divisions, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report variances from electrical characteristics noted on electrical drawings to the A/E before proceeding with rough-in work.

E. Obtain and review equipment submittals and shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.

F. Comply with requirements in Section 260553 for identification of electrical power supply conductor terminations.

3.02 STARTERS (CONTROLLERS)

A. Install non-packaged starters and wiring devices near motors or as indicated on the Drawings. Securely support and anchor in accordance with manufacturer’s installation instructions. Locate for proper operational access, including visibility for safety.

3.03 PROVISIONS FOR MECHANICAL CONTROLS

A. Provide 120 Volt, 20 Amp circuit at locations required and described in Section 230900. Coordinate exact locations prior to installation.

B. Install power metering equipment at panelboards and switchboards furnished by control system subcontractor at locations required and described in Section 230900.

3.04 EQUIPMENT SHORT CIRCUIT CURRENT RATING

A. All mechanical equipment, packaged systems, control panels, motor starters, motor controllers, variable frequency drives and similar equipment shall carry a Short Circuit Current Rating (SCCR) equal to or greater than the available fault current delivered from the electrical system. Coordinate final available fault currents with the contractors providing this equipment.

3.05 MECHANICAL – ELECTRICAL INTERFACE SCHEDULE

A. Establishing the separation of work between trades and subcontractors is not within scope of these Contract Documents. The following schedule is proposed for assistance in bidding only.

B. Unless otherwise indicated in the Contract Documents, mechanical equipment and controls are suggested to be furnished, installed, and wired in accordance with the following schedule. Coordinate work with Division 22 and 23 sections.

Item	Furnished By:	Installed By:	Power Wiring By:	Control Wiring By:
1. Equipment Motors:	M	M	E	M
2. Magnetic Motor Starters and Equipment Connections:				
a. Automatically Controlled with or without HOA Switches:	E	E	E	M
b. Manually Controlled:	E	E	E	E
c. Furnished with Mechanical Equipment, Factory Mounted:	M	M	E	M
d. Furnished with Mechanical Equipment, Field Mounted:	M	E	E	M
3. Disconnect Switches and 120 Volt Receptacles per IMC and NEC:	E	E	E	--
4. Manual Motor Starters, Thermal Overload Switches:	E	E	E	--
5. Combination Fire/Smoke Dampers, Smoke Dampers:	M	M	E	E
6. Section 230900 Automatic Temperature Controls: Valve and Damper Actuators, Low Voltage Electric Thermostats, Switches, other Miscellaneous Controls:	M	M	M	M
7. Electric Radiant Heating Panels, Baseboard Heaters, Cabinet Heaters, Unit Heaters:	M	M	E	M
8. Electric Duct Heating Coils:	M	M	E	M
9a. Duct Smoke Detectors:	E	M	E	E
9b. Relays and Ancillary Devices Associated with HVAC Unit Shutdown by Duct Smoke Detectors:	E	E	E	E
10. Electric Heat Trace:	M	M	E	M
11. Variable Frequency Drives:	M	M	E	M
12. Section 230900 Control Panels:	M	M	E	M

M = Division 22 and 23, Plumbing and HVAC
E = Division 26, Electrical
For purposes of the above table, responsibility of power and control wiring includes raceways, connections and other components as required for complete installation of wiring system.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes selective demolition of existing electrical work as indicated in the Contract Documents.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.01 EXISTING CONDITIONS

A. Dust Control: Provide protective measures to minimize transfer of noise, dust, dirt, and refuse to adjacent areas of building. Such measure may include dusttight barriers, temporary walls, portable exhaust fans, vacuum systems, and temporary partitioning.

B. Extent: Keep areas of demolition as clean and orderly as physically possible. Do not allow demolition debris to accumulate. Gather debris and dispose daily. Broom or vacuum-clean work areas on daily basis.

C. Protection: Protect existing equipment, furnishing, and systems with protective coverings. Protect finished surfaces including floors, ceilings, and walls.

3.02 DAMAGES

A. Repairs: Promptly repair damage to existing surfaces, equipment, finishes, or adjacent facilities at no cost to the Owner and to the satisfaction of the A/E and the Owner.

3.03 DEMOLITION

A. General: Provide demolition work required in existing building for removal of existing electrical equipment, raceways, and conductors and for installation of new electrical equipment, raceways, and conductors. Relocate and modify existing electrical equipment, raceways and conductors as required by general construction alterations and by installation of new electrical equipment, raceways, and conductors in existing building to achieve a complete and functioning installation as defined in the Contract Documents.

B. Extent: Remove and dispose of existing materials indicated in the Contract Documents to be removed.

C. Reuse: Do not reuse existing products unless indicated on the Drawings.

D. Materials to Owner: Deliver items to the Owner’s Representative as indicated in the Contract Documents.

E. Materials to Contractor: Materials other than those reserved by the Owner.

F. Existing Conditions: Comply with requirements in Division 01. Verify specific demolition work and operating conditions to be encountered from on-site review and coordination with the Owner. Maintain service to existing equipment and devices during new construction work as required by construction sequencing/scheduling provisions. In areas adjacent to new construction work, provide temporary services as necessary to meet these conditions. Protect active conductors encountered. Notify the A/E of utilities encountered whose services are not known.

G. Repair of Damages to Underground Utilities: Exact location of existing underground utilities is not definitely known. Should any underground utilities be damaged in excavations, restore such utilities without additional cost to the Owner.

H. Drilling of Concrete: Drill openings through existing concrete with diamond tipped rotary core-drilling equipment or carbide tipped drills.

I. Saw-Cutting of Concrete: Saw cut through existing concrete with diamond tipped or carbide tipped saw blade.

J. Outlet Boxes: Cover existing to remain outlet boxes in walls or ceilings as follows:
   1. Existing with mud ring: Provide blank stainless steel cover plate large enough to cover mud ring
   2. Existing without mud ring: Provide flat mud ring and blank stainless steel cover plate to ensure there are no holes or gaps between the box and the finish surface. Where gaps occur provide the following:
      a. Small gaps between outlet box and finished surface:
         1) Provide an oversized cover plate
      b. Large gaps between outlet box and finished surface:
         1) Provide patching and painting in accordance with Division 09 specifications.
         2) Provide an oversized cover plate

3.04 DISPOSAL OF DEMOLISHED MATERIALS

A. Disposal: Remove debris, rubbish, and other materials resulting from demolition operations from building site unless reinstalled or delivered to the Owner as indicated in the Contract Documents. Transport and legally dispose of material off site.

B. Burning: Burning of removed materials is not permitted on project site.

3.05 CLEAN-UP AND REPAIR

A. Clean-Up: Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protection and leave interior areas clean.

B. Repair: Repair demolition performed in excess of that required at no additional cost to Owner. Return structures and surfaces to conditions existing prior to commencement of demolition work or as directed by the Owner.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes wire, cable, splices, and terminations for systems 600 Volts and less and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 83, Thermoplastic-Insulated Wires and Cables.
   3. UL 62275, Cable Ties for Electrical Installations

C. Comply with NEC as applicable to construction and installation of electrical wire and cable. Electrical wire and cable UL listed and labeled.

D. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.

E. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of wire and cable.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of wire, cable, and appurtenance.

C. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 POWER AND LIGHTING CIRCUITS

A. Factory-fabricated conductors of sizes, ratings, materials and types indicated on the Drawings for each service. Where not indicated, select to comply with project's installation requirements and NEC standards. Comply with the following:
   1. UL 83.
   2. Copper Conductor - Stranded.
   3. Insulation type THHN/THWN-2 dual rated **or** XHHW-2, 600 Volt for circuits from 115 to 600 Volts.
   4. Use only 90 C insulated conductors based on 75 C ampacity tables of the NEC.

2.02 CONTROL AND SIGNAL CIRCUITS

A. Class 1:
   1. UL 83.
   2. Stranded copper conductor.

3. Insulation type THHN, or THWN, 600 Volt for circuits from 115 to 600 Volts.

B. Class 2 and 3:
   1. Copper conductor, 300 Volt insulation, rated 75 C in dry locations and 60 C in wet locations. Individual conductors twisted together and covered with non-metallic jacket unless otherwise noted on the Drawings.
   2. UL listed for use in air handling ducts and hollow spaces used as ducts and plenums.
   3. Category UTP cabling for electrical control systems:
      a. Cable type per system manufacturer and shop drawings.
      b. Comply with the most current technical characteristics of TIA-568-C standard.
      c. Comply with NFPA 262 CMP (plenum) rated, unless otherwise noted.

2.03 PLASTIC CABLE TIES

A. Teflon or nylon, locking type

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 WIRING AND CABLE INSTALLATION, GENERAL

A. Install electric conductors and cables as indicated on the Contract Drawings, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation," and in accordance with recognized industry practices.

B. Coordinate installation work with electrical raceway and equipment installation work for proper interface.

C. Pull cables by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device made through approved swivel connection. Non-metallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop to which pull wire can be attached. Remove insulation from conductors before forming loop. Larger sizes of cable may be pulled by using basket weave pulling grip, if pulling force does not exceed limits recommended by manufacturer. If pulling more than one cable, bind them together with friction tape before applying grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.

D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to conductors limited to 0.008 lbs. per circular mil of conductor cross-section area.

E. Pull in cable from end having the sharpest bend (bend closest to reel). Keep pulling tension to minimum by liberal use of lubricant, turning of reel, and slack feeding of cable into duct entrance. Employ not less than one person at reel and one in vault during this operation.

F. For training of cables: provide 12 times cable diameter minimum bend radius to inner surface of cable.

G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50 percent greater than specified above for training.

H. Apply wire and cable pulling compound recommended by specific cable manufacturer.

I. Seal cable ends unless splicing is done immediately.

J. Support cables in vaults, concrete trenches, and similar locations by cable racks. Secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator.

K. Follow manufacturer's instructions for splicing and cable terminations.

L. Provide separate neutral conductor for each circuit serving single phase loads, unless indicated otherwise on the Contract Drawings. Where shared neutrals are indicated for multi-wire branch circuits, provide circuit breaker handle ties per Section 262813.

M. Branch circuit wiring:

1. Group in separate raceways as indicated on the Contract Drawings. Where branch circuit raceways are not indicated on Contract Drawings, a maximum of three circuits may be installed in the same raceway if each circuit originates from the same panelboard.
2. GFCI Circuit Breakers: XHHW-2 insulation

3.05 WIRING METHODS, GENERAL

A. Install wiring in raceways unless indicated otherwise on the Contract Drawings or authorized by the A/E.

B. Install Wire After:

1. Interior of building is protected from weather.
2. Mechanical work likely to injure conductors is completed.
3. Conduits have been cleaned and moisture removed.

C. Neatly train and lace wiring inside boxes, equipment, and panel boards.

D. Clean raceway system before installing conductors.

E. Use half-lapped synthetic tape if taping is utilized for insulation purposes.

F. Provide conductor support devices as required by NEC in vertical conduit runs.

G. Torque conductor connections and terminations to manufacturer's recommended values.

H. Maintain minimum 12-inch clearance between open cabling and heat sources such as flues, steam pipes, and heating appliances.

3.06 MINIMUM SIZES

A. Minimum No. 12 AWG for power and lighting circuits.

B. Minimum No. 14 AWG for control wiring.

C. Power and lighting circuits with home run lengths greater than 100 feet. No. 10 AWG minimum.

D. Power and lighting circuits with home run lengths greater than 150 feet. No. 8 AWG minimum

3.07 CLASS 2 AND 3 CABLE INSTALLATION

A. Class 2 and 3 Cable: Install using open cabling support methods at indoor locations where allowed by codes, landlord/owner standards and where raceways are not required per Contract Drawings or for protection of cabling**.**

3.08 OPEN CABLING INSTALLATION

A. Class 2 and 3 cabling: run exposed as "open cabling" above accessible ceilings, accessible ceiling plenums and where exposed in unfinished spaces, unless otherwise noted. Install class 2 and 3 cabling in raceway above hard ceilings, where exposed in finished spaces and where subject to damage.

B. Provide all hanger supports and cable supports for cabling specified by Division 26, 27 and 28. All support structures adhere to the requirements in the National Electrical Code. Comply with requirements in Section 260529 Supporting Devices.

C. Install cable bundles horizontal with a maximum deflection of two inches from the bottom of the cable support.

D. Provide additional cable management products to protect exposed cabling and complete the installation of cabling in a neat professional manner.

E. Maintain 12” clear from mechanical equipment and ductwork, fire protection piping and electrical raceways systems. Where limited space exists for cable routing, cables may cross ducts, piping and conduit systems perpendicular with minimum 4” separation. Maintain separation from all mechanical and electrical equipment, ductwork, piping, conduit, clearance spaces and structure.

F. Maintain proper bend radius of cabling bundles and supports changing pathway direction as to not impact the physical jacket construction of the cabling. Replace cabling that becomes damaged during this transition in its entirety.

G. Follow manufacturer’s recommendations for quantity of cables supported in J-hooks and adjustable cable supports. Comply with requirements in Section 260529 Supporting Devices.

H. Observe the applicable requirements and recommended good practices contained within TIA-568-C standard for cabling installation requirements.

I. Protect exposed cables where subject to damage. Provide conduit sleeves with bushings at all wall, ceiling and floor penetrations.

3.09 WIRING SPLICES AND TERMINATIONS

A. Splice only in accessible junction boxes.

B. Splices and Taps:
   1. No. 10 AWG and smaller: Compression-set pressure connectors with insulating covers or screw-on pressure (wire nuts)
   2. No. 8 AWG and larger: Compression-set pressure connectors with insulating covers. Split bolt splices and connectors not acceptable.

C. Terminations: Eye-type compression lug when termination is to a bolt or screw terminal.
   1. 250 kcmil and larger, two-hole long barrel compression lugs.
   2. Smaller than 250 kcmil: Single hole compression lug.

D. Tape un-insulated portions of conductor and connectors with electrical tape to 150 percent of conductor insulation value.

E. Clean wires before installing lugs and connectors.

F. Make splices, taps, and terminations to carry full capacity of conductors without perceptible temperature rise.

G. Leave minimum 8 inches of pigtail at outlet boxes for connection to fixtures and devices. Where wiring is continued to other outlets, splice connection wire in a tap. In no case will continuity through double terminal of device be allowed for either hot or neutral leg of circuit.

H. Insulate ends of spare conductors with electrical tape or wire nut.

I. Terminate control circuit conductors at terminal blocks only.

J. Utilize eye or forked tongue type compression set terminator for conductors No. 12 AWG and smaller when termination is to a bolted or screw set type terminal block or terminal cabinet.

K. Make below grade splices in handholes and vaults watertight with epoxy resin type splicing kits similar to Scotchcast.

3.10 FIELD QUALITY CONTROL

A. Test for Wires and Cables in accordance with Section 260810.

B. Test Category 5e UTP cabling as follows:

1. Horizontal cabling: certified to meet or exceed the permanent link performance specifications for Category 5e horizontal cabling tested with a frequency range from 1MHz to 100 MHZ as defined in TIA-568-C.
2. Certifications include the following parameters for each pair of each cable installed:
    a. Building System
    b. Cable identification between system devices
    c. Date of test
    d. Test equipment manufacturer and model number
    e. Wire map
        1) Continuity to the remote end.
        2) Shorts between any two or more conductors
        3) Reversed pairs
        4) Split pairs
        5) Transposed pairs
        6) Any other miswiring
    f. Length
    g. Near-end crosstalk (NEXT)
    h. Power sum-near-end crosstalk (PS-NEXT)
    i. Return loss (RL)
    j. Propagation delay (PD)
    k. Delay skew (DS)
3. Test horizontal cabling using a Permanent Link configuration as defined in TIA-568-C.
4. Document test reports with an asterisk (*) or fails, identifying the reason for the test failure and a corrective action plan developed.
5. Re-test the permanent link after corrective action has been completed,.
6. Ensure 100 percent of the horizontal cabling system links pass all tests.

C. Organize test results by building system type and cable identification number. Provide test results including the date and time of when each test was saved in the memory of the tester. Record test results in both PDF and manufacturer software formats and provide in the O&M manuals.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes metal clad (MC) cable for branch circuit systems 600 Volts and less and associated appurtenance.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
   2. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. NFPA 70, National Electrical Code (NEC).
   4. UL 1569, Standard for Metal-Clad Cable.
   5. UL 1581, Reference Standard for Electrical Wires, Cables, and Flexible Cords.
   6. UL 83, Thermoplastic - Insulated Wires and Cables.
   7. UL 1479, Standard for Fire Tests of Through-Penetration Firestops.
   8. UL 44: Standard for Thermoset-Insulated Wires and Cables
   9. UL 1685: Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
   10. UL 2556, Standard for Safety Wire and Cable Test Methods

C. Comply with NEC as applicable to construction and installation of MC Cable. Cable UL listed and labeled.

D. Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.

E. Comply with applicable portions of ANSI/ASTM and IEEE Standards pertaining to construction of wire and cable.

F. Comply with UL 1569 for Metal Clad Cable. Include UL label and manufacturer’s “E” number.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each type of MC Cable and appurtenance.

C. Test Reports:
   1. Field test reports.
   2. UL test report for MC Cable.
   3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 METAL CLAD CABLES

A. Manufacturers:
   1. Southwire
   2. AFC Cable Systems, Inc.
   3. Encore

B. Branch Circuits:
   1. Single Circuit and Multi-circuit with color-coded conductors. Comply with requirements in Section 260553.
   2. Conductors: Stranded Copper
   3. Conductor insulation: Heat, flame, moisture resistant dielectric layer manufactured and tested in compliance with UL 83.
      a. Dry locations: THHN/THWN.
      b. Damp and wet locations: THHN/THWN-2
   4. Electrical and Physical Properties of Copper Conductors: Conform to applicable standards referenced above. Soft-annealed copper in compliance with ASTM B 3 or ASTM B 8.
   5. Ground Conductor: Insulated grounding conductors sized in accordance with UL 1569, cabled with circuit conductors and identified in compliance with UL 1569.
   6. Circuit and grounding conductors cabled (twisted) with lay length and covered with polypropylene or polyester assembly tape.
   7. Note: Select either galvanized or aluminum. Aluminum is less expensive and significantly lighter weight but not as strong as galvanized
   8. Armor:galvanized steel over cabled wire assembly with interlock in compliance with UL 1569.MC manufacture color system.
   9. Fittings: Malleable iron/steel, angled saddle type, electro zinc plated inside outside, equipped with nylon insulated throat fittings. Thomas and Betts series 3110 & 3150 series or approved. Direct bearing screw type fittings not acceptable. UL listed and labeled MC connectors manufactured for MC Cable Connectors.
   10. Anti-short bushings: Nylon.

C. Note: This is for outdoor, wet locations or use in concrete only. Typically not permitted so confirm with owner prior to use.
   1. Jacket: PVC applied over Armor

2.02 MC CABLE SUPPORTS

A. Cable Clamps, Straps, and Supports: Steel or malleable iron. Comply with requirements in Section 260529 .

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section. Protect exposed cable from damage. Remove cable which proves to have faulty wiring and provide new. Abandoning existing and pulling new not acceptable. Repair, repull, and restrap MC Cable determined by the A/E to be poor installation.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 METAL CLAD CABLE INSTALLATION

A. Provide metal clad cables as indicated on the Drawings, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.

B. Install metal clad cables only within room served with direct termination to outlet. Provide conduit and wire from panel to junction box above accessible ceiling within each room, before transition to metal clad cabling.

C. Install cables concealed in walls, and above accessible ceilings in spaces,

D. Route parallel and perpendicular to building planes.

E. Maintain minimum 6-inch clearance between cabling and piping. Maintain 12-inch clearance between cabling and heat sources such as flues, steam pipes, heating and hot water pipes, and heating appliances.

F. Where cabling is run in parallel, group on common supports. Comply with requirements in Section 260529

G. Coordinate installation work with equipment installation work for proper interface.

H. Provide anti-short bushings at cut ends of armor.

I. Install MC Cable After:
   1. Interior of building is protected from weather.
   2. Mechanical work likely to damage cables is completed.

J. Note: The paragraph below is intended for use when you allow MC cable for the entire job including home runs. Delete this paragraph is you only allow MC within a single room. Review lengths/loads and minimum sizes per project to confirm these minimums are acceptable

K. Minimum Sizes:
   1. No.12 AWG minimum for power and lighting circuits.
   2. No. 16 AWG minimum for 0-10V lighting control wiring.
   3. Power and lighting circuits with home run lengths greater than 100 feet. No. 10 AWG minimum.
   4. Power and lighting circuits with home run lengths greater than 150 feet. No. 8 AWG minimum.

L. Splice only in accessible junction boxes.

M. Verify continuity of each branch circuit conductor.

N. Tape un-insulated portions of conductor and connectors with electrical tape to 150 percent of conductor insulation value.

O. Include green wire ground. Jacket shall not serve as grounding means.

P. Cut cable using equipment exclusively designed for such use with adjustable cutting depth or automatic means of armor separation. Seatek, Thomas & Betts, or approved.

Q. Insulate ends of spare conductors with electrical tape or wire nut.

R. Label cable as it enters panel, at junction boxes where homerun cables become branch cable, and at branch terminations using permanent cable markers. Tyton, Burndy, Thomas and Betts or approved.

S. Distance Between Supports: Maximum 6-foot centers and within 6 inches of each outlet, and junction box.

T. Support cables below roof decking to provide minimum 1-1/2” separation from raceway surface to nearest surface of metal roof decking

U. Route cable around structural members.

V. Multi-Circuit Cables: a maximum of three circuits may be installed in a single multi-circuit cable if each circuit originates from the same panelboard. Provide a dedicated neutral for each branch circuit unless indicated otherwise on the Contract Drawings.

3.05 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test report in the Operation and Maintenance Manual.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes grounding and bonding systems, equipment, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. IEEE C2, National Electrical Safety Code (NESC).
2. IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System Part 2: Normal Measurements.
3. IEEE 837, Standard for Qualifying Permanent Connections Used in Substation Grounding
4. NFPA 70, National Electrical Code (NEC).
5. NFPA 780, Standard for the Installation of Lightning Protection Systems
6. UL 467, Standard for Grounding and Bonding Equipment.
7. UL486A-486B, Wire Connectors
8. ANSI C119.4, Electric connectors - connectors to use between Aluminum-to-aluminum or aluminum-to-copper conductors

C. Comply with NEC and IEEE requirements as applicable to electrical grounding and ground fault protection systems.

D. Products UL listed and labeled.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each item and appurtenance.

C. Shop Drawings: Plans showing dimensioned location of grounding system features, including ground rods, ground rings, test wells, grounding electrode system connections, and routing of grounding electrode conductors.

D. Test Reports:

1. Field test reports.
2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 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.

2.02 GROUNDING ELECTRODES AND CONDUCTORS

A. Ground Rods: Copper clad steel, 3/4 inch diameter by 10 foot long. Copper-Weld Erico, Burndy, Harger, Thomas & Betts or approved.

B. Bare Ground Conductors: Soft drawn copper. Stranded unless indicated otherwise. Tinned where indicated. Solid for No. 8AWG and smaller. Stranded conductors for No. 6 AWG and larger.

C. Insulated Ground Conductors: Copper with 600 Volt insulation in accordance with Section 260519.

D. Ground Bars: Predrilled rectangular bars of annealed copper, 1/4" inch by 4 inches with holes spaced 1-1/8 inches apart to accommodate lug connections. Length 18 inches unless indicated otherwise. Standoff insulators for wall-mounting.

2.03 GROUND CONNECTORS

A. Listed and labeled for applications and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connections: Exothermic-welding kits of type recommended by kit manufacturer for materials being joined and installation conditions. Manufacturer: Cadweld, Thermoweld, Thomas & Betts, or approved.

C. Compression Ground Connectors: Conform to IEEE 837 and UL 467.
   1. Cable-to-Cable Connections: Copper or copper alloy. Approved for direct burial or in concrete applications. Manufacturer: Thomas & Betts EZ-Ground® or approved.
   2. Cable-to-Busbar Connections: Two-hole long barrel compression lug, unless indicated otherwise on Contract Drawings.
   3. Cable-to-Cable Tray Connections: Two-hole long barrel compression lug.

D. Mechanical Ground Connectors: Conform to IEEE 837 and UL 467.
   1. Cable-to-Water Piping Connections: Two-piece silicon bronze with stainless steel bolts. Listed for direct bury.
   2. Split-Bolt Connectors: Not acceptable.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

C. Preparation of Surfaces: Clean contacting surfaces of ground connections to bright metal before connecting.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. System ground not to exceed maximum 5 ohms meggered resistance.

C. Ground each separately-derived system neutral to nearest building steel.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, underground metal water piping systems, and gas piping systems.

3.04 GROUNDING ELECTRODE AND CONDUCTOR INSTALLATION

A. Equipment Ground Conductor: Install separate, insulated equipment ground conductor in each feeder and branch circuit. Terminate each end on grounding lug, bus, and bushing and to intermediate metallic enclosures.

B. Isolated Ground Conductor: For isolated ground branch circuits and feeders, install insulated isolated ground conductor. Isolated ground conductor is in addition to equipment ground conductor. Terminate each end on isolated ground bus.

C. Connect grounding conductors to motors in accordance with NEC. Remove paint, dirt, and other surface coverings at grounding conductor connection points so that good metal-to-metal contact is made.

D. Bare Grounding Conductors Below Grade:
   1. Minimum 30 inches below grade.
   2. Not in contact with gravel fill or concrete. Provide Schedule 40 PVC sleeve where routing through concrete.
   3. Train neatly around foundations and footings.

E. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4/0 AWG. Bond to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

F. Size main grounding system per NEC. Provide conduit to protect ground wire from damage to an area 6 feet above floor.

G. Conductor to Conductors, Conductor to Steel, and Conductor to Ground Rod: Exothermic-welded type connectors. Cadweld, Thermoweld, Thomas & Betts, or approved.

H. When making bolted connection to aluminum and galvanized structures, apply corrosion-inhibitor to contact surfaces between cable, connector, and surface of structure. Penetrox A or approved.

I. Ground Bars: Install where indicated on Contract Drawings. Install horizontally at 12 inches above finished floor, unless indicated otherwise.

3.05 GROUND CONNECTORS

A. Welded Connections:
   1. Provide for underground connections.
   2. Provide for connections to structural steel.
   3. Provide for connections to ground bars where indicated.
   4. Provide full weld between coupling and ground rod at joint.
   5. Connect grounding conductors to ground rods at upper end of rod with end of rod and connection point below finished grade, except provide bolted connections at test wells and as otherwise indicated.

6. When making connections, wire brush or file point of contact to bare metal surface. Use welding cartridges and molds in accordance with manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and clean joint. Use connectors of specified size for conductors and ground rods. Notify A/E before backfilling ground connections.

B. Ground shields of shielded power and control cable at each splice and termination as recommended by manufacturer.

C. Ground metal sheathing and exposed vertical metal structural elements of building. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, instrument cabinets, raceways, and similar items carrying circuits to these devices.

3.06 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810.

B. Testing agency, approved by the Owner and the A/E, shall perform ground resistance testing of system. Perform test by means of fall-of-potential method. Maximum acceptable value 5 ohms.

1. Testing Instrument: Battery-powered or hand-cranked AC tester.
    a. Indicates ground resistance in ohms from digital decade switches when unit's self-contained meter indicates null condition.
    b. Range: 0.01 to 9990 ohms in 4 overlapping ranges.
    c. Null condition occurs when no current flows through potential electrodes.
    d. Instrument accuracy: Plus 2 percent or greater.
2. Fall-of-Potential Test:
    a. Connect instrument according to manufacturer's instruction.
    b. Place rod P2 at various locations in line between tested electrode and probe C2 and plot results on graph (distance vs. resistance). Take sufficient readings to yield portion of plotted curve as being constant (rate of resistance change becomes so small with respect to distance as to be insignificant).
3. Conduct 2 separate tests on opposite sides of grounding grid.
4. Report failure to obtain specified ground resistance to the A/E.

C. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

D. Include field test reports of grounding system in the Operation and Maintenance Manual.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes equipotential bonding and grounding system for telecommunications and low-voltage systems and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. CENELEC EN 50310, Application of Equipotential Bonding and Earthing in Buildings with Information Technology Equipment.
2. IEEE C2, National Electrical Safety Code (NESC).
3. IEEE 81, IEEE Guide For Measuring Earth Resistively, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements.
4. NFPA 70, National Electrical Code (NEC).
5. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises.
6. TIA-569-D, Commercial Building Standard for Telecommunications Pathways and Spaces.
7. TIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Building.
8. UL 467, Standard for Grounding and Bonding Equipment.

C. Equipment regularly catalogued items of manufacturer and supplied as complete unit in accordance with manufacturer's standard specifications with optional items required for proper installation, unless otherwise noted on the Drawings.

D. Comply with NEC, IEEE, TIA-607-C, and CENELEC EN 50310 requirements as applicable to grounding systems.

E. Products UL listed and labeled.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each item and appurtenance.

C. Test Reports:

1. Field test reports.
2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.04 DEFINITIONS

A. Bonding: Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and capacity to conduct safely any current likely to be imposed.

B. Bonding Conductor for Telecommunications: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.

C. Commercial Building: Building or portion thereof that is intended for office use.

D. Earthing: International term equivalent to grounding.

E. Effectively Grounded: Intentionally connected to earth through ground connection or connections of sufficient low impedance and having sufficient capacity to prevent buildup of currents that may result in undue hazard to connected equipment or to persons.

F. Electrical Room: Facility for housing electrical equipment, panelboards, and controls. Room is recognized interface between electrical backbone riser and associated pathway.

G. Entrance Facility (Telecommunications): Entrance to building for both public and private network service cables (including antennae) including entrance point at building wall and continuing to entrance room or space.

H. Entrance Point (Telecommunications): Point of emergence of telecommunications conductors through exterior wall, concrete floor slab, or from rigid metal conduit or an intermediate metal conduit.

I. Equipment Bonding Conductor (EBC): Conductor that connects equipment rack, server cabinet, PBX, and similar items to telecommunications grounding busbar to telecommunications main grounding busbar (TMGB), or telecommunications grounding busbar (TGB).

J. Equipment Room (Telecommunications): Centralized space for telecommunications equipment that serves occupants of building.

K. Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.

L. Ground: Conducting connection, whether intentional or accidental, between electrical circuit or equipment and earth or some conducting body that serves in place of earth.

M. Grounding Electrode System: Electrode(s) as specified in NEC.

N. Grounding Equalizer: Conductor that interconnects elements of telecommunications grounding infrastructure.

O. Pathway: Facility for placement of telecommunications cable.

P. Primary Protector: Protector located at building telecommunications entrance point and listed under UL 497.

Q. Protector: Device consisting of one or more protector units intended to limit abnormal surges on metallic communications circuits. Includes mounting assembly for protector units.

R. Protector Unit: Device intended to protect against either overvoltage or overcurrent or both. Unit may contain carbon arresters, gas tubes, solid state devices, heat coils, PTC devices, or combination of these components for specific application.

S. Telecommunications Room: Enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling as recognized location of horizontal cross-connect.

T. Telecommunications Bonding Backbone (TBB): Copper conductor extending from TMGB to farthest floor TGB.

U. Telecommunications Grounding Busbar (TGB): Busbar placed in convenient and accessible location and bonded by means of TBB to TMGB.

V. Telecommunications Main Grounding Busbar (TMGB): Busbar placed in convenient and accessible location and bonded by means of bonding conductor to service equipment (power) ground.

W. Termination Hardware: Device used to connect cables or wires for ease of cross connecting or for extension to another cable or equipment.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe Clamps: Copper, UL listed and labeled grounding connector with pre-drilled lug pad allowing 2 hold compression terminal. Size of connector to accommodate pipe size. Burndy GAR-TC Series or approved.

B. Communication Grounding Rods: Copper-clad steel, 1/2 inch by 15 foot long. Include ground connector. Burndy GAR Series, T&B GUV Series, or approved.

C. Telecommunications Bonding Backbone (TBB): Conductors bare No. 3/0 AWG stranded insulated copper conductor, unless otherwise noted.

D. Exothermic Welding: Appropriate fittings as required. Cadweld or Thermoweld.

E. Telecommunications Main Grounding Busbar (TMGB):

1. Copper plate, 1/4 inch thick by 4 inch wide by 20 inches long conforming to BICSI and TIA standards.
2. Pre-drilled for bolts to secure bar to insulating standoffs. Mounting holes 3/8 inch diameter spaced 5.75 inches apart. Include insulators to isolate busbars from wall and other mounting surfaces.
3. Busbar pre-drilled with hole pattern to accommodate 2-hole lugs as follows: 27 lugs with 5/8 inch hole centers and 3 lugs, 1 inch hole centers.
    a. Chatsworth Products, Inc., Part No. 40153-020

F. Telecommunications Grounding Busbar) (TGB):

1. Copper plate, 1/4 inch thick by 2 inch wide by 10 inches long conforming to BICSI and TIA standards.
2. Pre-drilled for bolts to secure bar to insulating standoffs. Mounting holes 3/8 inch diameter spaced 5.75 inches apart. Include insulators to isolate busbars from wall and other mounting surfaces.
3. Pre-drilled with hole pattern to accommodate 2-hole lugs as follows: 4 lugs with 5/8 inch hole centers and 3 lugs, 1 inch hole centers.
    a. Chatsworth Products, Inc., Part No. 13622-010

G. Cable Terminals: Two-hole, non-insulated copper compression long barrel terminal, requiring 3/8 inch bolts on 1 inch and 5/8 inch centers. Burndy YA-2TC Series, T&B 256-30695 Series, or approved.

H. Compression Taps: C-type to bond together 2 or more TBBs. Burndy YGHC Series or approved.

I. Raised Floor Grounding: No. 6 AWG stranded bare copper grounding conductor bonded via exothermic weld to raised floor pedestals as indicated on the Drawings.

J. Cable Tray Grounding:

1. Terminal bolted to cable tray such that No. 6 AWG stranded copper cable can be laid into terminal without cutting and splicing cable. Grounding terminal manufactured for that purpose.
2. Include ground straps at expansion joints and splice plates for electrical continuity.

K. Equipment Rack/Server Cabinet: Grounding kit for each equipment rack or rack enclosure.

L. Ferrous Conduit: Terminal bolted to conduit to allow laying No. 6 AWG stranded copper cable into terminal without cutting and splicing cable.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 GROUNDING INSTALLATION

A. Install TMGB/TGB at locations as indicated on the Drawings. Insulate busbar from its support. Install minimum 2 inch separation from wall to allow access to rear of busbar.

B. Connect bonding conductors for telecommunications from each equipment rack/server cabinet, cable tray, ferrous conduit, service equipment (power) ground, and similar items to TMGB and TGBs as indicated on the Drawings. Provide green insulated No. 6 AWG stranded copper conductor, unless otherwise noted.

C. For PBX systems and equipment manufacturers, a separate TGB may be required for each manufacturer's equipment.

D. Install bonding conductor for telecommunications from TMGB to electrical service grounding electrode in electrical room. Bonding conductor for telecommunications shall be same size as TBB as a minimum.

E. Bonding conductors installed in ferrous metal conduit in general, not acceptable. If it is necessary to route bonding conductors through ferrous conduit for more than 3 feet, bond conductors to each end of conduit with No. 6 AWG conductor.

F. Route bonding conductors as directly as possible. Avoid changes in elevation and sharp bends.

G. Cable Terminals:

1. Install manufacturers recommended compression die to compress terminal to cable at recommended compression pressure.
2. Terminate grounding system cable by compression terminals except connections to grounding rods and raised floor and cable tray grounding terminals. Connections to these items shall be as specified elsewhere in this specification section.

H. Exothermic Welding:

1. Use exothermic welding where grounding connections are made underground, embedded in masonry or concrete, and installed in other inaccessible spaces.
2. Follow manufacturer’s installation instructions.

3.05 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810.

B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

C. Test system at bonded points. Readings at any point maximum 5 ohms meggered resistance. Include field test results in the Operation and Maintenance Manual.

3.06 LABELING

A. Comply with requirements in Section 260553.

B. Label Telecommunications grounding components in accordance with TIA-607-C.

C. Label Telecommunications Main Grounding Busbar "TMGB".

D. Label TGBs with floor and an identifying number of a particular TGB. TGB of lowest numbered TR on the second floor would be labeled TGB201, the next TGB202, and so forth.

E. Install labels on grounding and bonding conductors as close as practicable to their point of termination. Install in readable position. Labels nonmetallic.

F. Label each Equipment Bonding Conductor (EBC) connected to a TMGB or TGB consecutively at each TMGB/TGB.

1. EBC to TMGB starts at EBC101 consecutively to EBC199.
2. EBC to TMGB201 starts at EBC201 consecutively to EBC299.
3. EBC to TMGB301 starts at EBC301 consecutively to EBC399.

G. Label each Telecommunications Bonding Backbone (TBB) conductor connected to TMGB consecutively. TBB to TMGB starts at TBB01.

END OF SECTION 260527

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes conduit and equipment supports, fastening hardware, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data, rated capacities and accessories for each item and appurtenance.

PART 2 PRODUCTS

2.01 MATERIAL

A. General: Built-up framing for electrical raceway and equipment supporting systems, including but not limited to channel, rod, clamps, and hardware. Comply with requirements in Section 260548 for seismic restraints. Unless design is shown on the Drawings, size for 400 percent of calculated load.

B. Channel: 12 gauge galvanized formed metal with or without pre-drilled holes, Pre-galvanized. Cooper B-Line, Unistrut, Powerstrut, or approved.

C. Beam Clamps, in Pairs, at each Supporting (Structural) Beam: B-line B441-22 and B441-22A; Superstrut U-501 and U-502; Unistrut P2785, P2786, and P1379S, or approved. Submit other manufacturers for approval with evidence proving clamp complies with IBC and ASCE 7-05 for seismic requirements. Submitted proof can consist of letter signed and stamped by a professional engineer licensed in engineering in the state in which the Work is performed.

D. Beam Clamps for Use with Rods: B-Line B751-J4, B751-J6, B751-J9, and B751-J12; Superstrut U-569; Unistrut P2824-6, P2824-9, and P2824-12, or approved. Submit other manufacturers for approval with evidence proving clamp complies with seismic requirements. Submitted proof can consist of letter signed and stamped by a professional engineer licensed in engineering in the state in which the Work is performed.

E. Fittings for Attaching Channel-to-Channel for Built-Up Framing: Unistrut P6028, P6033, P6069, P6290, P6291, P6326, P6331, P6332, P6346, P6358A, P6359, P6381, P6382, P6726A, P6917, P6962, or approved.

F. Connectors for Bracing: Unistrut P6186, P7097, P7098, P7100, P7101, P7108, P7109, P7110, P6546, or approved.

G. Hardware, including Nuts (Locking Type), Bolts, and Set Screws: Corrosion resistant, designed for intended use.

H. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

I. Mechanical-Expansion Anchors: Insert-wedge-type,stainless steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

J. 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

K. Hanger Rods: Threaded steel

L. Spring Steel Conduit Clips: Erico K series or approved.

M. MC Cable Support Brackets: Erico MCS Series or approved.

N. Circular Cable Retainer:
   1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
      a. Manufacturer: Erico Caddy, Part No. CAT CR50

O. J-Hooks:
   1. J-hooks shall have a galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
      a. Manufacturer: Erico Caddy or approved:
         1) 1” Dia., Part No. CAT16HP
         2) 1-5/16” Dia., Part No. CAT21HP
         3) 2” Dia., Part No. CAT32HP
         4) Note: The paragraph below is intended for use when you have 100+ cables in a bundle

P. Adjustable Cable Support:
   1. Adjustable cable supports shall be of steel and polyethylene, plenum rated, with unlocking and locking bar allowing additional cables to be added easily after installation.
      a. Manufacturer: Erico Caddy, Part No. CAT425

Q. Outlet Box Support:
   1. Where more than one outlet box is shown on the Contract Drawings, and indicated to be at same elevation, align them exactly on center lines horizontally with wall mounting bracket.
      a. Manufacturer: Cooper B-Line Series BB8 or approved:

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 SUPPORTING DEVICES INSTALLATION

A. Comply with requirements in Section 260548 for seismic restraints.
   1. Install diagonal bracing for trapeze support systems at 2 right angle planes to brace against:
      a. Horizontal and torsional movement lateral seismic forces.
      b. Vertical (uplift) movement caused by vertical seismic forces.
      c. Horizontal distortions in conduit system caused by wire pulling.

B. Unless otherwise shown on the Contract Drawings, attach connectors to vertical framing members with 2 bolts

C. Install toggle bolts or hollow wall fasteners in hollow masonry, plaster, and gypsum board partitions and walls. Install expansion anchors or preset inserts in solid masonry walls, self-drilling anchors, and expansion anchors on concrete surfaces. Comply with requirements in Section 260548 for seismic anchors.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Beam clamps MSS SP-58, Type 19 or 23, complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements

E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under nuts.

F. Free Standing Electrical Equipment: Bolt to concrete base with leveling channels. Comply with requirements in Section 260510 for concrete base and Section 260548 for seismic restraints.

G. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

H. Transformer Support: Comply with requirements in Section 262200.

I. Lighting Fixture Supports: Fixture support wires for recessed ceilings, match ceiling support requirements. All fixture supports to comply with requirements in Section 265100 and Section 260548.

J. Open Cabling Support Installation
   1. Provide hanger supports and cable supports for cabling specified in Division 26. All support structures shall adhere to the requirements in the National Electrical Code.
   2. Space cabling supports no further than 4’-0" apart.

3. Install cabling supports on their own dedicated support system.

K. Raceways:
   1. Single raceway runs: Spacing to comply with requirements of Section 260533
      a. Suspended: support by threaded rod with spring steel conduit clips. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings
      b. Mounted to building structure:double hole pipe straps.
   2. Two or more parallel runs of raceway: Install trapeze support systems with 25 percent space (6 inches minimum) for future conduit runs. Refer to Section 260533 for spacing requirements.
   3. Welding conduit and conduit fittings to structure not acceptable.
   4. Spacing: Space so that fittings are accessible to accommodate pulling or splicing.

L. MC Cable:
   1. Single cable runs mounted to building structure with single hole straps specifically designed for MC cabling. Spacing shall comply with requirements of Section 260521.
   2. Where two or more cables runs are routed in parallel, mount to building structure with MC Cable brackets. Spacing shall comply with requirements of Section 260521.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes conduit, electrical metallic tubing, wireway, surface metal raceway, and associated appurtenances within building perimeter.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

C. Refer to Section 260543 underground electrical work beyond building perimeter.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances. Comply with local Utility requirements and standards.

B. Codes and Standards:
   1. UL 1, Standard for Flexible Metal Conduit.
   2. UL 5, Standard for Surface Metal Raceways and Fittings.
   3. UL 6, Standard for Rigid Metal Conduit.
   4. UL 360, Standard for Liquid-Tight Flexible Metal Conduit.
   5. UL 514B, Standard for Conduit, Tubing, and Cable Fittings.
   6. UL 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
   7. UL 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
   8. UL 797, Standard for Metallic Tubing – Steel.
   9. UL 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
   10. UL 1242, Standard for Intermediate Metal Conduit – Steel.
   11. UL 2420, Standard for RTRC Conduit and Fittings for underground – Fiberglass
   12. UL 2515, Standard for RTRC Conduit and Fittings for above ground - Fiberglass

C. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.

D. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements of raceway systems.

E. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes specified and whose products have been in satisfactory use in similar service for not less than 3 years.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data for each type of raceway system and appurtenance.

PART 2 PRODUCTS

2.01 RIGID METAL CONDUIT (RMC) AND FITTINGS

A. Ferrous Metal Conduit: Steel, UL 6, hot-dip galvanized.

B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

2.02 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

A. Ferrous Metal Conduit: Steel, UL 1242, hot-dip galvanized.

B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

2.03 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Ferrous Metal Conduit: Steel, UL 797, hot-dip galvanized.

B. Fittings: UL 514B, galvanized steel, insulated throat, rain tight compression ring type through 1-1/4 inch, set screw type for 1-1/2 inch and larger. Drive-on type and cast fittings not acceptable.

2.04 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Ferrous Metal Conduit: Steel, UL 1, galvanized. UL listed for grounding as available. Aluminum and flexible metallic tubing not acceptable.

B. Fittings: Insulated throat, UL 514B, galvanized steel, UL listed for grounding as available.

2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

A. Ferrous Metal Conduit: Galvanized with PVC weatherproof cover, UL 360 listed for grounding as available.

B. Fittings: Insulated throat, UL 514B, galvanized steel, UL listed for grounding as available.

2.06 RIGID NON-METALLIC CONDUIT

A. PVC Conduit: Schedule 40, UL 651, rigid type unless noted otherwise. UL 651A Type A permitted for underground concrete duct banks.

B. Fittings: UL 651, UL 651A, UL 2420 and UL 2515.

1. For electric (power) duct, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC) with minimum 48 inch
2. For telecommunications service provider ducts, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC)
3. For telecommunications on-site distribution ducts, 90 degree elbows with minimum 36 inch radius factory manufactured rigid steel (RMC).

2.07 SURFACE METAL RACEWAY

A. UL 5, sheet metal channel with fitted cover. Type and size as shown on the Drawings.

B. Finish: Enamel. Field paint to match wall color.

C. Fittings, Boxes, and Extension Rings: Designed for use with raceway systems.

D. All raceway and fittings to be supplied by one manufacturer.

E. Manufacturers: Mono-Systems, Wiremold, or approved.

2.08 CONDUIT BODIES

A. Conduit bodies cast malleable iron, zinc or cadmium plated with threaded connections. Covers gasketed, blank steel, or cast malleable iron, zinc or cadmium plated, and of same manufacturer as conduit body. Where conduit bodies are used as junction or splice boxes, comply with NEC.

B. Conduit bodies (Smart LB) for telecommunications cables shall be die cast aluminum, gray powder coat paint finish, threaded connections with internal built-in radius. Covers gasketed, die cast aluminum, and of same manufacturer as conduit body. Madison Electric or approved equal.
   1. 1-1/4” Smart LB, Madison Electric, KLB120
   2. 2-1/2” Smart LB, Madison Electric, KLB 250
   3. 4” Smart LB, Madison Electric, KLB400

2.09 WIREWAY AND AUXILIARY GUTTER

A. UL 870, lay-in type, with hinged cover but without knockouts.

B. Size: As shown on the Drawings, 4 by 4 inch minimum.

C. Finish: Rust-inhibiting primer coat with manufacturer’s standard enamel finish.

2.10 EXPANSION FITTINGS

A. Malleable iron, hot-dip galvanized allowing 4 inches (plus or minus 2 inches) conduit movement.
   1. RGC and IMC Raceway: OZ/Gedney Type AX series, Thomas and Betts Type EJG series or approved
   2. EMT Raceway: OZ/GedneyType TX series, Thomas and Betts Type XJG series or approved.

2.11 SEALING FITTINGS

A. Wall Sealing Fittings: At each wall sealing fitting, include conduit seal fitting, OZ/Gedney FSK Series or approved.

B. Raceway Stubups and Stubouts: Conduit seals together with wall sealing fittings. OZ/Gedney CSB Series or approved.

C. For Exterior Wall Penetrations below Grade: Include sealing bushing at interior end of penetrating raceway. Only threaded fittings are permitted in entering raceways ahead of sealing bushing. OZ/Gedney Type CSB or approved.

2.12 CONDUIT SUPPORTS

A. Conduit Clamps, Straps, and Supports: Steel or malleable iron. Comply with requirements in Section 260529.

2.13 FIRE RATED SEALING COMPOUND

A. Dow Corning 3-548 Silicone RTV Foam or approved.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 RACEWAY SIZING, ARRANGEMENT, AND SUPPORT

A. Unless otherwise shown on the Drawings, size conduit for conductor type installed. Minimum size 3/4 inch.

B. Install conduit to maintain headroom and present neat appearance in unfinished spaces. Install a minimum of 9’-6” above finished floor in spaces unless otherwise indicated on the Contract Drawings.

C. Install conduit concealed in walls, below floors, and above ceiling in spaces, except conduit may be exposed in mechanical rooms, electrical rooms, and similar unfinished spaces. Horizontal conduit installation is not allowed in floor slab unless specifically noted on electrical and structural drawings.

D. Route conduit parallel and perpendicular to building planes.

E. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, heating and hot water pipes, and heating appliances.

F. Brace conduit or conduit supports to prevent distortion of alignment by wire-pulling operations.

G. Where conduit is run in parallel, group on formed channel supports. Comply with requirements in Section 260529.

H. Do not fasten or support with wire or perforated pipe straps. Remove temporary conduit supports used during construction before conductors are pulled.

I. Raceway to be routed around structural members. Structural Engineer to approve proposed modifications of structural elements prior to commencement of work.

3.05 RACEWAY INSTALLATION

A. Cut conduit square using a saw or pipe cutter. Deburr cut ends.

B. Bring conduit to shoulder of fittings and couplings and tighten securely.

C. Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.

D. Do not use conduit bodies to make sharp changes in direction unless shown on the Drawings.

E. Use hydraulic one-shot conduit bender or factory elbows for bends in 2 inch conduit and larger.

F. Provide plastic bushings on conduit stubs used for transition from conduit to open cable runs.

G. During construction, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

H. Distance Between Supports:

1. Threaded Rigid Metal Raceways: Maximum ten foot centers and within 18 inches of each outlet, junction box, and bend.
2. Electrical Metallic Tubing: Maximum ten foot centers at each bend and within 12 inches of each outlet, junction box, and coupling.
3. Surface Metal Raceway, Auxiliary Gutter, and Wireway: Maximum 5 foot centers or in accordance with manufacturer’s instruction, whichever is less, unless otherwise shown on the Drawings.

I. Provide polyester mule tape with printed footage indicators secured at each end of each empty conduit, except sleeves and nipples. Identify with tags at each end indicating origin and destination of empty conduit. Minimum tensile strength of 1250 pounds for conduits 2-inch and smaller and 2500 pounds for conduits larger than 2-inch.

J. Route conduit through roof inside openings for ductwork where possible. Otherwise, install through roof jack and seal weather tight.

K. Install no more than equivalent or four 90 degree bends between boxes.

L. Avoid moisture traps where possible. Where unavoidable, install junction box with drain fitting at conduit low point.

M. Raceway Installation below Slab on Grade:
   1. Installed a minimum of 2 inches below bottom of slab.
   2. Arrange and slope raceway to drain away from building.
   3. Install insulated grounding bushings at conduits stubbed up or out from underground unless capped for future (spare).
   4. Wipe PVC conduit clean and dry before jointing. Apply full even coat of cement to entire area to be inserted into fitting. Let joint cure for minimum 20 minutes.
   5. Install conduit that stub up through floor at such depth that exposed conduit is vertical and no curved section of elbow is visible.

N. Sealing of Conduit Penetrations:
   1. Exterior Wall Surfaces Above Grade: Seal around penetrations with caulking approved by the A/E. For concrete construction above ground level, cast conduit in wall or core drill wall and hard pack with mixture of equal parts of sand and cement.
   2. Exterior Wall Surfaces Below Grade: Cast conduit into wall (and floor) or use manufactured seal assembly cast in place.
   3. Roofs: Install mopped and flashing roof jack and where conduit penetrates roof membrane.
   4. Fire Rated Construction: Seal penetrations with fire rated sealing compound to maintain fire rating of construction penetrated.

O. Sealing of Raceways: Seal interior of raceways that pass through building roof and through outside walls of building, above or below grade. Seal on end inside building. Use raceway sealing fittings manufactured for purpose sealed with non-hardening, compound-type mastic, specially designed for such service. Pack around wires in raceways.

P. Raceways on exterior surface of building: install only when shown on the Drawings and as approved by the A/E.

Q. Where flexible metal or liquid tight flexible metal conduit is installed, install bonding conductor to insure electrical continuity of raceway. Route bonding jumper inside conduit and terminate at grounding bushing or grounding locknut installed on inside of junction boxes at each side of flexible section. In instances where this method is not feasible (such as when cast boxes with hubs are used or where required by the NEC, route bonding jumper on outside of flexible conduit and terminate in accordance with methods acceptable to the AHJ.

R. Raceway shall not penetrate sheet metal ducts.

S. Branch circuits: install overhead, except circuits serving floorboxes, outdoor circuits or unless indicated otherwise on the Contract Documents.

T. Support raceways below roof decking: provide minimum 1-1/2” separation from raceway surface to nearest surface of metal roof decking.

U. Spare Raceways: Install 6 spare 3/4 inch conduits (capped) from each recessed/flush mounted branch panelboard into ceiling space or mechanical platform if one exists. Extend conduits required distance necessary to reach accessible ceiling space.

V. In finished areas with exposed structure, subject to the approval of the A/E, raceways may be installed exposed. Install raceways as high as possible, provide minimum 1-1/2" separation from raceway surface to nearest surface of metal roof decking, and neatly arranged. Submit shop drawing indicating routing of proposed surface raceways and boxes in finished areas.

3.06 SURFACE METAL RACEWAY INSTALLATION

A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.

B. Install insulating bushings and inserts at connections to outlets and corner fittings.

C. Maintain grounding continuity between raceway components for continuous grounding path.

D. Fastener Option: Use manufacturer's standard clips and straps for installed purpose.

3.07 AUXILIARY GUTTER INSTALLATION

A. Bolt auxiliary gutter to steel channels fastened to wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight gutter.

C. Mount rain tight gutter in horizontal position only.

3.08 RACEWAY SCHEDULE

A. Rigid Metal Conduit:
   1. Acceptable in all locations except as modified in this section.
   2. Where in contact with earth or concrete, install protective coating consisting of spirally wrapped 20 mil PVC tape with 1/2 inch minimum overlap – 3M Scotchrap Tape 51 or approved - or utilize PVC Coated Rigid Metal Conduit. Completely wrap and tape field joints.
   3. Required for exposed raceways in areas subject to physical damage.

B. PVC Coated Rigid Metal Conduit:
   1. Required in corrosive environments or where indicated on the Contract Drawings.

C. Intermediate Metal Conduit:
   1. May be used in lieu of rigid metal conduit unless otherwise prohibited by code or indicated on the Contract Drawings.
   2. Not acceptable for circuits over 600 Volts.

D. Electrical Metallic Tubing:
   1. Acceptable for dry interior locations where not exposed to moisture or physical damage.
   2. Not acceptable for circuits over 600 Volts.

E. Rigid Non-Metallic Conduit:
   1. Acceptable below concrete slab on grade installed a minimum of 2 inches below bottom of slab.
   2. Acceptable within masonry walls.
   3. Not acceptable for exposed raceways extending through floor slab; utilize Rigid Metal Conduit or Fiberglass (RTRC.
   4. Not acceptable for bends 45 degrees and greater unless concrete encased; utilize Rigid Metal Conduit as specified herein, PVC Coated Rigid Metal Conduit or Fiberglass (RTRC). Field bends not acceptable.

5. Concrete encased where indicated on Contract Drawings or where required by Code or Utility.

F. Flexible Steel Conduit:
   1. For connections to recessed light fixtures and devices installed in suspended ceilings, maximum six foot length.
   2. For connections to motors, transformers and other equipment subject to vibration. Minimum of three foot and maximum of six foot length with 90 degree loop.

G. Liquid-Tight Flexible Metal Conduit.
   1. For pump motors and equipment subject to vibration in damp and wet locations, in areas subject to being washed down, and for machinery where cutting oil is used. Minimum of three foot and maximum of six foot length with 90 degree loop.

H. Surface Metal and Multi-Outlet Raceway: Install where indicated on the Contract Drawings.

I. Auxiliary Gutters and Wireways: Install where indicated on the Contract Drawings and as required in unfinished spaces. Elsewhere as approved by the A/E.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes outlet, junction, and pull boxes and associated appurtenances required to enclose devices, permit pulling conductors, and for wire splices and branches.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NFPA 70, National Electrical Code (NEC).
   3. UL 514A, Metallic Outlet Boxes.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of outlet box and appurtenance.

PART 2 PRODUCTS

2.01 OUTLET BOXES FOR INTERIOR WIRING

A. General: Outlet and pull boxes pressed steel, zinc coated with plaster ring where applicable, minimum 4 inch size.

B. Telecommunications and Audio Visual: Outlet and pull boxes galvanized steel, with plaster ring where applicable, minimum 4-11/16 inch, 3-1/4-inches deep.

C. Surface Metal Raceway: Boxes of same manufacturer and to match raceway. Boxes to accommodate standard devices and device plates.

D. Concrete and Masonry: Boxes for casting in concrete and mounting in masonry walls of type specifically designed for that purpose.

E. Ceiling Outlet Boxes: Galvanized octagonal 4 inch, 1-1/2 inches deep (without fixture stud) and 2-1/8 inch deep (with fixture stud).

F. Sheet Metal Boxes Larger than 12 Inches in any Dimension: Include hinged enclosure.

G. Cut in Outlet Boxes: Retro-Ring 205RAC to position 4" sq. steel junction box in covered wall cavity.

2.02 OUTLET BOXES FOR EXTERIOR WIRING

A. General: Weather resistant and rain tight, with appropriate covers, gaskets, and screws.

B. Above Grade: Outlet and junction boxes cast or malleable iron or cast of corrosion resistant alloy compatible with raceway to which they are connected. Pull boxes fabricated of hot dipped galvanized heavy gage steel. Boxes with gasketed covers.

C. Below Grade: Provide underground vaults as specified in Section 260543.

2.03 OUTLET BOXES CONTAINING MULTIPLE DEVICES

A. Outlet Boxes Containing Emergency and Normal Devices: Permitted only with steel barriers manufactured especially for purpose of dividing outlet box into 2 completely separate compartments.

B. Outlet Boxes Containing Multiple Devices and Wiring Rated over 150 Volts to Ground and Over 300 Volts Between Conductors: Permitted only with steel barrier manufactured especially for purpose of dividing outlet box into separate compartments for each device having exposed live parts.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 COORDINATION OF OUTLET BOX LOCATIONS

A. Locate as shown on the Drawings and as required to facilitate pulling. Limit number of bends per NEC.

B. Electrical box locations shown on the Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets before roughing in.

C. Locate outlet boxes to allow access. If inaccessible, furnish, arrange, and pay for installation of access doors.

D. Coordinate Work of this section with the Work of other sections and trades to avoid conflicts. Check and verify door swings and locations of built-in cabinets, plumbing, heating, and ventilating equipment.

E. Install outlet boxes of sizes and at locations necessary to serve equipment furnished under this or other divisions of the specifications. Make final connections thereto. Outlet boxes required if equipment is furnished with pigtail for external connection, does not have space to accommodate branch circuit wiring, or requires wire with insulation rating different from branch circuit wiring. Review equipment Shop Drawings for required outlet locations.

F. Where more than one outlet box is shown on the Drawings, and indicated to be at same elevation or one above the other, align them exactly on center lines horizontally or vertically. Relocate outlet boxes which are not so installed (including lighting, receptacle, power, signal, and temperature control outlets) at no additional cost to the Owner.

G. Centered on Built-In Work: In the case of doors, cabinets, recessed or similar features, or where outlet boxes are centered between such features, such as between door jamb and cabinet, make these outlet box locations exact. Relocate outlet boxes which are not centered.

H. Flush mount boxes with front edge of box or plaster ring even with finished surface of wall and ceiling, except those mounted above accessible ceilings and where surface mounting is permitted.

I. Locate to maintain headroom and to present a neat appearance.

J. Route conduit from switch and receptacle boxes in walls vertically to space above ceiling. Install junction box before horizontal run.

K. Offset outlet boxes minimum of one stud horizontal separation between flush boxes mounted on opposite sides of acoustic rated common wall.

L. Install outlet boxes with minimum 6 inch horizontal separation between closest edges of flush boxes mounted on opposite sides of common wall.

M. Ceiling Locations: Locate outlet either at corner joint or in center of a panel, whichever is closer to normal spacing. Locate outlet boxes in same room in same panel locations.

N. Conceal outlet boxes for electric water coolers behind cooler unit housing.

3.05 OUTLET BOX INSTALLATION

A. Anchor boxes so they will not shift or rock when devices are operated (including insertion and removal of cord caps).

B. Firmly anchor flush outlet boxes directly or with concealed bracing to studs and joists.

C. Close unused openings.

D. Support boxes independently of conduit except for cast outlet boxes that are connected to 2 rigid metal conduits, both supported within 12 inches of outlet box.

E. Use multiple-gang outlet boxes where 2 or more devices are mounted together. Do not use sectional boxes.

F. Install blank covers or plates over outlet boxes that do not contain devices.

G. In inaccessible ceiling areas, install outlet and junction boxes within 6 inches of recessed luminaire to be accessible through luminaire ceiling openings.

H. Install recessed outlet boxes in finished areas. Secure outlet boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall and adjustable steel channel fasteners for flush ceiling outlet boxes.

I. Install outlet boxes in walls without damaging wall insulation.

J. Seal conduit boxes, telephone boxes, and similar items air tight with acoustical caulk where located in acoustical rated walls that are not fire rated.

K. Install outlet boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for outlet boxes. Use outlet boxes with sufficient depth to permit conduit hubs to be located in masonry void space.

L. Install pull boxes to be accessible after completion of building construction.

3.06 ELECTRICAL WORK IN COUNTERBACKS, MILLWORK, AND CASEWORK

A. Install as shown on the Drawings. Furnish templates to other trades for drilling and cutting to ensure accurate location of electrical fixtures (outlets and devices) as verified with the A/E. Install wiring, devices, plates, and connections required by said fixtures.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes floor outlet devices for power and communications and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 514A, Metallic Outlet Boxes.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of outlet device and appurtenance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flush Type Outlet Devices: Hubbell, Wiremold, Steel City, or approved.

B. Poke Through Type Outlet Devices: Wiremold, Hubbell, or approved.

2.02 MULTI-SERVICE POKE THROUGH FLOOR OUTLET DEVICES

A. General:
   1. Consist of pedestal floor outlet assembly, raceway through floor, and factory equipped fire rated center coupling with inorganic chemical panels that will expand on exposure to high heat to form flame, smoke, toxic fume, and waterproof seal within entire assembly. Include means to level assembly in place.
   2. Manufacturer: Wiremold 6AT series or approved.

B. Cover: Flush Style Cover Assembly.
   1. Manufacturer: Wiremold 6CTCBK or approved.

C. Conduit Fittings: Bottom Feed Center Mount Plates.
   1. Bottom feed center mount plates shall be provided to accept a minimum 1-1/4-inch conduit, unless otherwise noted in the Contract Drawings.
   2. Manufacturer: Wiremold CHA Series or approved.

D. Receptacles: Two pre-wired 20A factory installed duplex receptacles.

E. Telecommunication Outlets: Center Mount Device Plates.
   1. Center mount device plates shall be provided to accommodate low-voltage and/or audio visual devices as indicated in the Contract Documents.
   2. Manufacturer: Wiremold 6AT series or approved.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 FLOOR OUTLET DEVICE INSTALLATION

A. Install and anchor floor outlet devices shown on the Drawings. Coordinate exact location with the A/E.

B. Attach conduits to cast iron housing.

C. Align coverplate over top of housing and tighten screws.

D. Level box and pour concrete.

E. Adjust top surface to level and flush with finished floor.

3.05 CARPET FLANGE INSTALLATION

A. Install after final floor covering has been installed.

3.06 CORE DRILLING FLOORS

A. Perform coring of floors for installation of poke through devices in a neat workmanlike manner and as recommended by the manufacturer. Patch or replace floor construction and finish damaged by installation of outlet devices to original condition or as directed by the A/E.

B. Review floor construction type with the A/E prior to core drilling. X-ray post tensioned slabs to verify acceptable location of core drill.

C. When core drilling over an occupied floor, make provisions to prevent damage to floor. Repair or replace items damaged at no additional cost to the Owner.

D. Where building construction will not permit core drilling, provide sleeves in floor slab to permit installation of outlet devices. Verify exact locations with the A/E.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable tray systems as shown on the drawings.

B. Cable tray systems are defined to include, but are not limited to straight sections of cable trays, bends, tees, elbows, drop-outs, covers, supports and accessories.

C. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work of this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances.

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. National Electrical Manufacturers Association:
      a. NEMA VE1 Metallic Cable Tray Systems.
      b. NEMA VE2 Cable Tray Installation Guidelines.
   3. ASTM International:
      a. ASTM A123/A123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. ASTM A510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
      c. ASTM B633 - Electrodeposited Coatings of Zinc on Iron and Steel.
      d. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   4. International Electrotechnical Commission:
      a. IEC 61537 – Cable Management - Cable Tray Systems and Cable Ladder Systems.
   5. TIA-569-D: Commercial Building Standard for Telecommunications Pathways and Spaces.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer’s technical product data and installation instructions for each type of cable tray and appurtenance.

C. Shop Drawings: Indicate (using large scale) details of construction conditions, joints and accessories, dimensions, and finishes.

PART 2 PRODUCTS

2.01 TYPE OF CABLE TRAY

A. Cable tray shall be continuous, rigid, welded steel wire mesh cable management system to permit continuous ventilation of cables and maximum dissipation of heat.

B. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 12 inches on center. Spacing in radiused fittings shall be 12 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

C. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) mechanically fastened to the side rails. Rungs shall be spaced 9 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width.

D. Solid bottom type tray shall consist of two longitudinal members (side rails) with a solid sheet over rungs spaced on 12” centers.

2.02 MATERIALS AND FINISH

A. Wire mesh type shall be continuous rigid, carbon steel, welded at intersections. Material shall contain an electrozinc finish.

B. Aluminum Ladder Tray: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.

2.03 CONSTRUCTION

A. Wire mesh cable tray shall be manufactured with Safe-T-Edge design with the lateral wires welded to the bottom edge of the top wires eliminating any sharp edges.

B. Ladder tray straight sections, fitting side rails and rungs and fabricated parts shall be manufactured with aluminum.

C. The solid bottom cable tray shall consist of two longitudinal members (side rails) with a solid sheet over rungs spaced on 12” centers.

2.04 DIMENSIONS

A. Wire mesh type cable tray shall be 4 inches in overall height. Width 12 inches.

B. Aluminum ladder tray shall consist of two longitudinal members that are 4 inches deep (side rails) with transverse members (rungs) welded to the side rails.

C. The ladder tray shall be 12 inches in width and rungs shall be spaced 12 inches on center.

D. Straight cable tray sections shall be supplied in standard 10’-0” sections, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.

2.05 MANUFACTURERS

A. Wire Mesh Cable Trays:

1. Manufacturer shall be Cablofil, or approved equal:
   a. 12”x4”: Cablofil Part No. CF 105/300.

2.06 SPLICE PLATES

A. Cable tray sections shall be mechanically and electronically continuous at all splices, changes in elevation, etc. Connections between sections shall attach using hardware and accessories of the same manufacturer as the cable tray and shall be installed per manufacturer’s recommendations.

B. Connections shall be listed by a Nationally Recognized Testing Laboratory as electrically continuous for purpose of grounding continuity, or supplemental bonding jumpers shall be provided at connections.

C. Splicing assembly shall be UL rated as a bonding interconnect between cable tray sections.
   1. Cablofil Part No. EDRN.

2.07 BEND RADIUS SWEEPS

A. Provide sweeping bends in cable tray pathway as shown on the contract drawings. Field modify cable tray as required. Edges shall be sanded to a smooth finish and shall be free of sharp edges. Bend radius sweeps shall meet the requirements of TIA-569-D standard.

B. Bend radius support assemblies shall lock the cable tray sweep between cut sections of the side wall of the cable tray.

C. Bend radius support assemblies shall utilize the FAS system.
   1. Cablofil Part No. FASLOCK XL.

D. Spacing in radiused fittings shall be 12 inches and measured at the center of the cable tray width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

2.08 CEILING SUPPORTS

A. Provide manufacturer's recommended support mechanism or Unistrut support of cable tray for installation above the ceiling space. Unistrut width shall be a maximum of 2 inches greater than the longest width of cable tray.

B. Threaded rod shall be supported on each side of the support mechanism. Center hung supports shall be prohibited.

C. Provide all components for securing threaded rod to the ceiling structure, support and cable tray.

D. Cable tray supports shall be placed so that the support spans shall not exceed 5'-0" on center.

E. Unistrut supports shall utilize the FAS system.
   1. Cablofil Part No. FASP 400.

F. Supports shall be installed utilizing hanger rod brackets for 3/8" ATR or 1/2" ATR or using 1/4" ATR through Redi-Rail holes on the top flange.
   1. B-Line Part No. 9(3/8)-R238.

G. Support Brackets for trapeze supports:
   1. B-Line Part No. 9ZN-5512, 9ZN-5524.
   2. B-Line Part No. 9P-5512-22SH, 9P-5524-22SH or approved equal.

2.09 WALL MOUNT SUPPORT

A. Provide manufacturer's wall mounted brackets or Unistrut supports for cable tray installation on vertical and horizontal pathways mounted to the wall structure. Unistrut width shall be a maximum of 2 inches greater than the longest width of cable tray.

B. Provide necessary bolt and anchoring devices to attach cable tray and supports to the wall structure.

C. Unistrut supports for vertical transitions shall utilize the FAS Profile system.
   1. Cablofil Part No. FASP 300.

D. L-bracket supports for horizontal mounting shall utilize the FAS Profile system.
   1. Cablofil Part No. FASL 300.

E. Support Brackets for wall mount supports:
   1. B-Line part No. 9ZN-5512-WB, 9ZN-5524-WB.

F. Cable trays installed adjacent to walls shall utilize wall mounted brackets.
   1. Cooper B-Line Part No. B494-12, B494-24 or approved equal.

2.10 LOADING CAPACITIES

A. Wire mesh cable trays shall be capable of carrying uniformly distributed cable load of 88.7 pounds per foot when supported on 8' foot span when supported as a simple span and tested per NEMA VE1 Section 5.2.

2.11 FITTINGS

A. Provide pre-manufactured T-intersections and 90-degree horizontal and vertical directional fittings for cable tray pathways. Field modification of straight sections to provide directional changes shall be prohibited.

B. Fittings shall have a minimum radius of 24 inches to accommodate cables installed in trays.

2.12 ACCESSORIES

A. Include related accessory items such as dropouts, end plates, barrier strips to separate services in trays support and seismic bracing components, grounding lugs, and installation rollers. Covers furnished for cable protection for vertical riser trays as they penetrate floors and similar applications.

B. Seismic Bracing Kit:
   1. Provide seismic bracing of cable tray. Seismic bracing shall meet the requirements of the AHJ.
      a. Cablofil Part No. SZMCKIT.

C. Cable Entry/Exit Supports:
   1. For horizontal and backbone cabling entering and exiting the cable tray from the side or bottom, provide a bend radius support assembly to protect the cables from sharp bends.
      a. Cablofil Part No. CABLEXIT100.
   2. For horizontal and backbone cabling entering and exiting at the end of a cable tray pathway, provide a bend radius support assembly to protect the cables from sharp bends.
      a. Cablofil Part No. DROPOUT KIT.
      b. B-Line part No. 9A-R104-12, 9A-R104-24.
      c. B-Line part No. 9A-1104-12, 9A-R104-24.

D. Mounting Bracket:
   1. Provide mounting brackets for telecommunications devices mounted to the side of the cable tray. Bracket shall zinc plated steel and shall provide EIA/TIA panel mounting holes on both sides
      a. B-Line part No. 9Z-MB1-4, 9Z-MB1-4.
      b. Cablofil Part No. C 50.

E. Cable Rollers:
   1. Provide cable rollers for the installation of cabling in the cable tray pathway. Rollers shall be placed at all changes in direction, height transitions, before and after wall penetrations and entrances into telecommunications rooms.
      a. Cablofil Part No. FAS ROLLER.

F. Straight Section Barrier Strip:
   1. Provide barrier strip for separation of system cabling.
      a. 4", Cablofil Part No. COT 105.
      b. 4", B-Line Part No. 73AR-120.

G. Conduit to Tray Adapters:
   1. 1” conduit, Cablofil Part No. C50CC1.
   2. 1-1/4” conduit, Cablofil Part No. C50CC114.
   3. 1, 1-1/4 conduit, B-Line Part No. 9G-1158-1,11/4.

H. Provide all grounding and bonding of cable tray pathway to the nearest telecommunications grounding busbar.

I. Provide all miscellaneous hardware and components for a complete and operational pathway system.

PART 3 EXECUTION

3.01 GENERAL

A. Install, apply, erect, and perform the work in accordance with Article 1.2 Quality Assurance provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Installation of cable trays shall be in accordance with applicable portions of TIA-569-D, Commercial Building Standards for Telecommunications Pathways and Spaces.

C. Cable tray shall be braced or anchored to resist a lateral force facing in any direction in accordance with the IBC, NEC and all local amendments to these codes and/or any other applicable requirements of the AHJ.

D. Contractor shall coordinate with the project structural engineer and the AHJ to determine the extent seismic bracing is required. Provide seismic bracing as required by the structural engineer and by the AHJ.

E. At the completion of installation, the cable tray system shall be level and plumb, and shall present a neat appearance. Cable tray interiors shall have no sharp edges or protrusions (to prevent abrasions of cabling or injury to personnel).

F. Install fire protection at all wall and floor penetrations. Install firestop material within installed cable trays after cabling has been installed through slot or sleeve penetrations.

3.02 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.03 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.04 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. Install cable tray system at locations indicated on the drawings. Installation shall be in accordance with manufacturer’s instructions and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.

B. Support the cable tray on 5’ centers for a total of 2 supports for every 10' span when the cable tray is supported from the ceiling. Support cable tray at every transition. Support cable tray utilizing wall mount brackets or Unistrut hangers.

C. Provide additional brackets on ends, and two additional brackets at tees and corners. Securely fasten cable tray to brackets and supports using clamps manufactured for the purpose. Provide all required inserts, hardware and supports.

D. Coordinate cable tray with electrical, mechanical and structural systems as necessary to properly integrate installation of cable tray.

E. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.

F. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE2 guidelines, or in accordance with manufacturer's instructions.

G. Cutting:
   1. Provide mechanical or power operated bolt cutters for providing changes in direction and height transitions with the cable tray. Adhere to manufacturer’s recommendations for devices and tools to provide the installation of the cable tray.
   2. Cut wires in accordance with manufacturer’s instructions.
   3. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
   4. Cut each wire with one clean cut to eliminate grinding or touch-up.

H. Install cable tray system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

I. Cable tray shall be grounded in accordance with manufacturer’s specifications and shall comply with requirements in Sections 260526 Grounding and 260527 Telecommunications Grounding System.

3.05 TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes isolation pads, spring isolators, restrained spring isolators, restraint cables, hanger rod stiffeners, anchorage bushings and washers, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation and seismic restraint device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to the AHJ.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

C. Delegated-Design Submittal: For vibration isolation and seismic restraint details indicate to comply with performance requirements and design criteria, including analysis data signed and sealed by professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.
      b. Comply with requirements in other Division 26 sections for equipment mounted outdoors.
   2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
   3. Field fabricated supports.
   4. Seismic Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By agency acceptable to AHJ, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Welding Certificates.

E. Test Reports:

1. Field test reports.
2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.04 PERFORMANCE REQUIREMENTS

A. General: A single supplier shall furnish isolation mounts, pads, seismic restraints, sway braces, related hardware, and fabricate isolation bases for the project unless otherwise specified.

B. Responsibility: This supplier shall be responsible for selection and installation supervision of vibration isolators. Prepare engineering drawings and details and submit to the A/E. Perform installation supervision and provide adjustment instructions.

C. Seismic Restraints:

1. Design and select restraint devices for ducts, pipes, and equipment to meet seismic requirements defined in IBC and ASCE 7-05. Prepare calculations based on coefficients included on the structural drawings. Refer to the structural drawings for allowable methods and loads.
2. Retain an engineer, specialty consultant, or seismic restraint device manufacturer to design and develop seismic restraint systems and perform calculations based on actual equipment data.
3. Engineer, specialty consultant, or seismic restraint device manufacturer shall coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed. Pay any additional structural engineering services fee.
4. Shop Drawings, details, and calculations shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

A. Manufacturers: Amber/Booth, California Dynamics Corporation, Kinetics Noise Control, Mason Industries, Vibro-Acoustics, Vibration Mountings & Controls, or approved.

B. Isolation Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
2. Minimum Additional Travel: 50 percent of required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4 inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed. Factory-drilled baseplate bonded to 1/4 inch thick neoprene or rubber isolator pad attached to baseplate underside. Adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and AHJ.
3. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.02 SEISMIC RESTRAINT DEVICES

A. Manufacturers: Amber/Booth, California Dynamics Corporation, Cooper B-Line, Hilti, Mason Industries, TOLCO, Unistrut, or approved.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements as defined in reports by an agency acceptable to AHJ.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components minimum 4 times maximum seismic forces to which they will be subjected.

C. Restraint Cables: ASTM A 492 stainless steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service. Include minimum 2 clamping bolts for cable engagement.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene with a flat washer face.

H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of 8 times diameter.

I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to the AHJ.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces. Welding stiffeners to rods not acceptable.

C. Strength of Support and Seismic Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.05 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
   1. Install restrained isolators on electrical equipment.
   2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic restraint devices using methods approved by agency acceptable to AHJ providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall mounted equipment, arranged to provide resilient media where equipment or equipment mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated on the Drawings, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, and at concrete members.

D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the A/E if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, and grout has achieved full design strength.

3. Mechanical Anchors: Protect threads from damage during anchor installation. Install sleeve anchors with sleeve fully engaged in structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from bottom of hole and progressing toward surface in such a manner as to avoid introduction of air pockets in adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections and branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.07 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Obtain the A/E’s approval before transmitting test loads to structure. Install temporary load-spreading members.
2. Test at least 4 of each type and size of installed anchors and fasteners selected by the A/E.
3. Test to 90 percent of rated proof load of device.
4. Measure isolator restraint clearance.
5. Measure isolator deflection.
6. Verify snubber minimum clearances.
7. If a device fails test, modify installations of same type and retest until satisfactory results are achieved.

B. Remove and replace malfunctioning units, provide new, and retest as specified above.

C. Prepare test and inspection reports. Include copy of reports in the Operation and Maintenance Manual.

3.08 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes nameplates, wire and cable markers, conduit color coding, buried duct marking tape, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Nameplate schedule.

PART 2 PRODUCTS

2.01 IDENTIFICATION MATERIAL

A. Nameplates:
   1. Engraved three-layer laminated plastic.
      a. Normal Power: White letters on black background.
   2. Control Panels and Equipment (Lighting and Receptacle Control): 1/2 inch high letters to identify equipment designation. 1/4 inch high letters to identify source, control panel name and space and zone controlled as designated on the Drawings..
   3. Enclosed Circuit Breakers, Disconnect Switches, Motor Starters: 1/4 inch high letters to identify load served and source.
   4. Digital Control Switches: 1/4 inch engraved letters on push button or cover to identify control zone.
   5. Feeders: 1/4 inch high letters to identify feeder ampacity, phase conductor size and quantity.

B. Adhesive Printed Labels:
   1. Laminated tape – Brother TZe Series 12 mm width tape or equivalent with adhesive back suitable for exterior locations.
      a. Normal Power: Black letters on clear background.
   2. Switches: 1/4 inch letters to identify load controlled.
   3. Receptacles: 1/4 inch letters to identify panelboard, circuit number and where identified as Dedicated, identify equipment designation as shown on panel schedule
   4. Lighting control devices: 1/4 inch letters to identify lighting control device designation as shown on shop drawings and lighting control program

C. Outlet boxes, junction boxes and pull boxes for emergency system devices and circuits orange in color, both inside and outside.

D. Outlet boxes, junction boxes and pull boxes for fire alarm system devices and conductors: red in color, both inside and outside.

E. Permanent felt marker for junction and pull box.
   1. Normal/Standby/Emergency Power: Black letters indicating circuit notation.

2. Lighting controls: Black letters indicating “Lighting Control Device” and relays

F. Wire and Cable Markers:
   1. Split sleeve or tubing type. Vinyl impregnated cloth, vinyl, and mylar self-adhesive types not acceptable.
   2. Color code wire in accordance with the coding shown in Decal Detail below. Conductors of power systems in this building (plant) are identified as follows:

Conductor	240/120 Volt
A Phase (Left Bus In Panel):	Black
B Phase (Center Bus In Panel):	Red
C Phase (Right Bus In Panel):	Blue
Neutral:	White
Equipment Ground:	Green

   3. Where dedicated neutral conductors are provided for single phase circuits, neutral conductor shall have a colored stripe to match the color of the corresponding phase conductor.

G. Phase Identification: Vinyl colored electrical tape.

H. Detectable Buried Duct Marking Tape:
   1. Electrical (Power) Ducts: Six inch wide red tape with words "CAUTION - ELECTRIC LINE BURIED BELOW". 3M Scotch #408 or approved.
   2. Communications/Telephone Ducts: Six inch wide orange tape with the words "CAUTION - TELEPHONE LINE BURIED BELOW". 3M Scotch #411 or approved.

I. Electrical Hazard Marking Tape: Black and yellow striped vinyl 2 inch wide hazard tape, Identi-Tape #VH2BKY or equal.

J. Directory Cards: Directory cards shall consist of heavy cardstock, metallic mounting frames and plastic covers. Mounting frames attached to the back side of panelboard or lighting control panel doors. Directories shall contain typewritten text indicating the circuit breaker or control relay number, type of load served and room number in which each load is located. Unused circuit breakers or control relays designated with “SPARE” written in pencil. Spaces for future circuit breakers left blank. Circuit designations on directory cards shall match the installed conditions with respect to loads and physical arrangement within panelboards.

K. Wiring Color Code Schedules: Prepared using a color printer and laminated between two layers of clear plastic. Schedules shall show color designation for each phase, neutral and ground of each system voltage. Schedule size, 130 mm by 180 mm (5″ by 7″).

L. Arc Flash Hazard Safety Signs: Product safety signs in accordance with ANSI Standard Z535.4 requirements. An electrical hazard (lightning) graphic surrounded by a yellow triangle at the left of each sign. At the top of the right side of the sign, in an orange signal word block, the signal word “Warning” shall appear together with an exclamation mark surrounded by a triangle. Underneath the signal word block, include the message “Arc Flash Hazard” printed on the first line, followed by “Available Fault Current” and “Appropriate PPE Required” on the second line. The sign shall also indicate the flash protection boundary in inches and the incident energy at 460 mm (18″) in cal/cm², in accordance with the requirements of NFPA 70E.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. Description: Install, apply, erect, and perform work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, more stringent requirements govern.

B. Nameplates:

1. Degrease and clean surfaces to receive nameplates.
2. Install nameplates parallel to equipment lines.
3. Secure nameplates to equipment fronts using screws or rivets. Adhesives not acceptable.

C. Wire Identification:

1. Install wire markers on conductors in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
2. Install solid colored jackets for wire sizes smaller than number 8 AWG. Wire sizes larger than number 10 AWG may be taped at both ends and at pull and junction boxes with appropriate colored tape. Color coding tape to completely encircle conductor at least 3 inches wide.

D. Felt Marker Identification: Apply on front of cover in non-finished areas, such as mechanical/electrical rooms, above ceilings, and similar locations, and on back of cover in finished areas.

E. Provide black and yellow striped vinyl 2” wide hazard tape on floor and stencil “Electrical Hazard-Keep Clear” on floor, spaced as to not exceed 4 feet on center to identify code required clearance in front of electrical equipment including switchboards, panelboards, motor control centers, transformers, transfer switches, etc. in unfinished spaces such as electrical and mechanical rooms.

3.04 INSTALLATION

A. General:

1. Provide identification for electrical equipment as specified herein.
2. Attach identification in durable manner, suitable to each respective type of identification. Securely fasten nameplates to equipment with two (2) rivets. Wiring color code schedules fastened to equipment with permanent adhesive.

B. Distribution Panelboards and Switchboards: Provide the following nameplates and schedules.

1. Nameplates: Provide for each distribution panelboard and switchboard. Install nameplates on the outside of the equipment enclosures above the incoming line sections.

2. Overcurrent protective device nameplate:. Install nameplates on the outside of the equipment enclosure adjacent to each device. .
3. Wiring color code schedule: attach to the exterior of each switchboard and each distribution panelboard. Locate schedules adjacent to the main incoming line sections.
4. Feeder nameplate: attach to the exterior of each switchboard and distribution panelboard to identify the source feeder.

C. Panelboards: Provide the following nameplates and schedules
1. Directory cards: Provide in each panelboard. Update room numbers and descriptions to match final owner approved room name/number. Place directory card in holder behind plastic cover.
2. Provide a reduced copy of each panel schedule contained in the Contract Documents, showing actual configuration. Provided panel schedules in addition to the typewritten panelboard directories. Place schedules in directory frame.
3. Provide a wiring color code schedule attached to each panelboard. Install schedules on the inside of panelboard doors.
4. Provide a feeder tag nameplate attached to the exterior of each panelboard to identify the source feeder

D. Control Panels/Equipment:
1. Nameplate: attach to the outside, front of enclosure for each relay panel, control units and control equipment. Nameplate text shall include the relay panel name or space and zone controlled as designated on the Drawings.

E. Provide an arc flash hazard safety sign attached to equipment indicated in power studies. Locate signs so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. On panelboards located in mechanical and electrical rooms, attach the signs on the outside of panelboard enclosures. On all other panelboards, attach the signs on the dead fronts or the back side of the panel doors, so that signs are not visible when panelboard doors are closed.

F. Motor Starters:
1. Provide a nameplate on the outside, front of each starter and variable frequency drive enclosure. Nameplate text shall include the name of load served as designated on the Drawings.

G. Signaling and Communications Systems Cabinets:
1. Provide a nameplate on the outside of each cabinet above door. Nameplate text shall include the system name as designated on the Drawings and the cabinet function.

H. Disconnect Switches:
1. Provide a nameplate on the outside front of each disconnect switch enclosure. Nameplate text shall include the name of the load controlled as designated on the Drawings, and also the designation of the equipment that serves as the power source for the circuit that supplies the disconnect.
2. Provide a feeder tag nameplate attached to the exterior of each disconnect that has overcurrent protection to identify the source feeder

I. Relays and Time Switches:
1. Provide a nameplate on the outside front of each relay and time switch enclosure. Nameplate text shall include the name of the load controlled as designated on the Drawings.

J. Contactors:
   1. Provide a nameplate on the outside front of each contactor enclosure. Nameplate text shall include the contactor name as designated on the Drawings and the name of the load controlled.

K. Control Switches:
   1. Provide a nameplate for each equipment control switch with a device plate as specified in Section 262726. Nameplate text shall include the name of the load controlled as designated on the Drawings.
   2. Provide a nameplate or printed label on each control switch that does not have a device plate as specified in Section 262726. Verify type with Architect's Consultant. Text shall include the name of the load controlled as designated on the Drawings.

L. Wiring Devices:
   1. Receptacle Labels:
      a. Indicate panelboard and circuit number.
      b. Where noted with equipment description on plan drawing, provide label indicating equipment to be connected as spelled out in panel schedule e.g., refrigerator, microwave, copier, printer, etc.
   2. Provide an engraved printed label for each switch that controls luminaires not within sight of the switch or that controls receptacles. Engraved printed label text shall include the type and location of the load controlled.

M. Junction Boxes and Pull Boxes:
   1. Provide nameplates on the outside of the front cover of junction boxes and pull boxes in finished areas and of junction boxes and pull boxes that are larger than 150 mm by 150 mm (6″ by 6″). Nameplate text shall designate the system for which wiring is to be enclosed in the box. In the case of power system junction boxes or pull boxes, the nameplate text shall also include the panelboard name and circuit number.
   2. Junction boxes and pull boxes 150 mm by 150 mm (6″ by 6″) or smaller in unfinished areas and above accessible ceilings must be color coded by spray painting the outside edges of the box and spray painting the cover with the following colors:

240/120 VAC Power:	Unpainted
Fire Alarm & Detection:	Red
Security and Video Surveillance:	Purple
Telecommunications:	Blue
Television:	Black
Audio-video:	Gold

   3. After painting, mark the covers of power system junction boxes and pull boxes with the panelboard name and circuit numbers. Marking must be done with a wide-tip, permanent-ink black marker.

N. Outlet Boxes:
   1. Outlet boxes for emergency power and fire alarm circuits must be color coded by spray painting the box inside and outside with the following colors:

Fire Alarm & Detection:	Red

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes testing requirements for individual components, equipment, systems, and integration to ensure intended facility operation. Test equipment per manufacturer guidelines and industry standards. Test modes of operation and interlocks and alarm functions. This section presents a guideline of system testing. Provide complete, comprehensive testing in addition to minimum requirements specified in individual sections and in this section.

B. Training: Include comprehensive Owner operation and maintenance training of individual components, equipment, and systems. Training includes normal operation and alternate modes of operations.

C. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. ANSI/NETA ATS 2017, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ANSI/NETA MTS-2015, Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems.
   3. NFPA 70B, Recommended Practice for Electrical Equipment Maintenance.
   4. NFPA 70, National Electrical Code (NEC).

C. Testing Agency: Testing shall be accomplished by an approved testing agency. Retain services of a NETA certified firm or approved. Testing agency shall not be associated with manufacturer of equipment or systems under test.

D. Perform testing and inspections with the assistance of a factory-authorized service representative, where indicated in individual specification sections.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Qualifications: Testing agency qualifications.

C. Testing Plan and Schedule: Detailed plan and schedule of testing, and training for acceptance by the Owner and the A/E prior to initiation of work.

D. Test Procedures: Test procedures and sample test forms.

E. Test Reports: Submit detailed report of testing functions with associated results. Include date of testing and corresponding line item for system tested and individual components. Include testing checklists for each system and device tested. Record for each line item test results that comply with requirements. Record for each line item test results that do not comply with requirements, corrective actions taken to achieve compliance with requirements and retest date and confirmation.

F. Settings of Adjustable Devices: Record as-left set points of all adjustable devices.

G. Include copy of reports in the Operation and Maintenance Manual.

H. Certification: Certification that tests have been completed.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 GENERAL

A. Perform acceptance tests in accordance with manufacturer’s recommendations, NFPA 70 and ANSI/NETA ATS.

B. Report any system, material, or workmanship which is found defective on basis of electrical inspections and tests to the A/E.

C. If test reveals a fault or problem, remove and replace malfunctioning units. Repeat entire test until problem is corrected. Submit additional written test reports.

D. Maintain written record of tests. Upon completion of project, assemble and certify final test report and include in the Operation and Maintenance Manual. Compile field test reports signed by individuals performing the tests.

3.05 GENERAL COMPONENT AND EQUIPMENT TESTING REQUIREMENTS

A. Phase Relationship Tests: Check connections to existing and new equipment for proper phase relationship. During such check, disconnect devices which could be damaged by application of voltage or reversed phase rotation.

B. Grounding:

1. Test each ground electrode system. Comply with requirements in Sections 260526 and 260527.
2. Visual and Continuity Test: Perform for each of the following ground connections:
    a. Equipment ground connections.
    b. Cable tray grounding.

C. Overcurrent Protective Device Factory Tests: Submit documentation of factory testing of distribution circuit breakers as specified in Section 262813.

3.06 LIGHTING CONTROLS TESTING

A. Test lighting controls, components and systems in accordance with local codes, manufacturer recommendations.

B. Test each device to confirm operation per manufacturer recommendations and design requirements.

C. Document each component, device and system tested and include “as-left” settings for all adjustable settings. Include a matrix which identifies device, type and location at a minimum.

3.07 REPORTS

A. Prepare test reports for each system, equipment and device tested. Include copy of each test report in the Operation and Maintenance Manual. Utilize test forms for systems and equipment tested. Use manufacturer’s standard or other appropriate test forms commensurate with test performed. Test reports shall include the following.

1. Summary of project.
2. Description of equipment tested.
3. Description of test.
4. Test results including retesting results.
5. Test dates.
6. Tester's name.
7. Witnesses (when required).
8. Corrective work.
9. Acceptance criteria.
10. Conclusions and recommendations.
11. Appendix including appropriate test forms.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes design, furnish, and install of lighting and plug load control system(s) required to form complete coordinated system(s) ready for operation. Contract Documents indicate minimum scope and performance criteria. It is the responsibility of the lighting controls manufacturer/vendor/contractor to provide a complete system.

B. Digital lighting controls: Stand-alone and Networked energy saving intelligent lighting control system including lighting control panels, network interface modules, emergency lighting transfer devices, as well as digital wall switches, occupancy sensors, daylighting controls, and associated appurtenances.

C. Analog lighting controls: Energy saving lighting control devices including wall switches, occupancy sensors with power supplies, emergency lighting transfer devices, daylighting controls, contactors and associated appurtenances.

D. Receptacle/Plug load controls: Plug load control devices including contactors and relays.

E. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. NEMA 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts.
   2. NFPA 70, National Electrical Code (NEC).
   3. UL 508, Standard for Industrial Control Panels.
   4. UL 916, Standard for Energy Management Equipment.
   5. UL 917, Standard for Clock Operated Switches.
   6. UL 924, Standard for Emergency Lighting and Power Equipment.
   7. Washington State Energy Code

C. Comply with NEC, NEMA, and FCC emission requirements for Class A applications.

D. UL Approvals: Relay panels and accessory devices UL listed and labeled under UL 916. Custom relay panels UL listed and labeled under UL 508. Automatic load control relays UL listed and labeled under UL 924. Branch Circuit Emergency Lighting Transfer Switch UL listed and labeled under UL 1008.

E. Certification: Manufacturer shall certify that products will meet product specifications and local energy codes. If any additional equipment is required to meet coverage patterns and local energy codes, provide additional equipment at no additional cost to the Owner.

1.03 DESIGN/PERFORMANCE REQUIREMENTS

A. Design, furnish, and install complete operable lighting control system(s) in accordance with the latest adopted editions of energy code and Owner requirements.

B. Drawings reflect minimum Owner requirements. The Contractor’s scope of work shall include but not limited to the following:
   1. Complete lighting control system based on the available architectural, civil, structural, mechanical and electrical drawings.

2. Wiring systems associated with lighting controls.
3. Providing additional occupancy sensors, photo sensors, daylight sensors, low voltage switches, relays, dimming modules, UL 924 control devices, control panels, and power supplies associated with lighting controls system.

C. Networked and Stand-Alone digital lighting controls shall accommodate the square-footage coverage requirements for each space controlled as indicated on the lighting zone control plans. Provide relays, control modules, dimming modules, occupancy sensors, switches, daylighting sensors, astronomical timeclocks,, networking equipment and cabling, plug/load relays and controllers, contactors and accessories that suit the required lighting and electrical system parameters.

1.04 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of lighting control system and components. Include digital cable, analog cable, termination types, wire connectors, manufacturer specific back boxes/supporting equipment.

C. Shop Drawings:
1. Floor plans showing wall occupancy sensors, light switches, relays, plug/load controllers, contactors, power supplies, dimming modules, network controllers, and mechanical control interface locations. Include typical installation and mounting diagrams for networking dimming and occupancy control devices. Above ceiling devices to be shown on the floor plans.
2. Reflected ceiling plans showing occupancy sensors, daylighting sensor. Include typical installation and mounting diagrams for occupancy and daylighting control devices.
3. Detailed point to point wiring diagrams.
4. System one-line diagram showing panels, number and types of switches and sensors, and building energy management system interface.
5. Request for engraved switch verbiage
6. Drawings for each panel showing hardware configuration and numbering.
7. Panel wiring schedules.
8. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
9. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

D. Commissioning/Test Reports:
1. Field Test Reports.
2. Commissioning Plan with Test Procedures.

E. Closeout Submittals:
1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
2. Operation and Maintenance Manual:
   a. Include approved Shop Drawings and Product Data.
   b. Engraved switch identification.
   c. Include Sequence of Operation, identifying operation for each room/ space and accent lights.
   d. Include manufacturer's maintenance information.

e. Operation and Maintenance Data: Include detailed information on device programming and setup.

f. Include startup and test reports.

1.05 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.06 WARRANTY

A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Digital Lighting Control: Subject to compliance with requirements, Acuity n-Light, Wattstopper DLM, Osram Encelium, Intelligent Lighting Controls (ILC).

B. Analog Lighting Control: Components with single use function, subject to compliance with requirements, Leviton, Sensor Switch, Lutron, Wattstopper, Hubbell.

2.02 SYSTEM DESCRIPTION

A. Space Control System: Electrically operated, electrically supervised, lighting control system as described herein. Include control units, power supplies, relays, dimming output control devices, input control devices including occupancy sensors, photo sensors and control switches, wiring, cabling, conduit, fittings, and accessories required for a complete operating system.

B. System Types (indicated in the contract documents):

1. Digital control: Digital controllers for lighting zones, fixtures and/or plug loads. Provide controllers to match the lighting and plug load control requirements. System, control, and features include:
   a. Stand-alone digital control system: Digital control within a single space to bind room loads to the connected control devices in the space. Control functions are limited to the devices connected to the stand alone digital control system.
      1) Self-configuring digital controller(s) with all digital parameter data programmed into non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
   b. Networked digital control system: Digital control of devices visible through the network and capable of complete system control including scheduling, room device parameter administration, power monitoring, and reporting device status. The network will have a single user interface point to program or administer the system.
   c. Digitally addressable control devices:
      1) On/Off control relays.
      2) Dimming control devices: 0-10V, phase dimming.
      3) Plug load control relays.
      4) Tunable control devices.

d. Digital inputs:
    1) Occupancy sensors.
    2) Photo sensors.
    3) On/Off/Scene and dimming control switches.
    4) Partition sensors.
e. Configuration tools: Allows complete configuration and reconfiguration of the Space. Must be able to tune system without the use of ladders.

2. Analog control: Single function analog devices to control lighting fixture and/or plug loads. Provide devices to match the lighting and plug load control requirements indicated in contract documents.
    a. Analog control devices:
        1) Line voltage control devices receive input from analog low voltage control devices and include the following:
            a) On/Off universal voltage power pack.
            b) Plug load control on/off universal voltage power pack.
        2) Low voltage control devices provide inputs to line voltage control devices or directly to light fixtures and include:
            a) Occupancy sensors.
            b) Photo sensors.
            c) Momentary contact On/Off Switches.
            d) Occupancy sensor control switches W/ 0-10V dimming control where indicated.

C. Comply with requirements in Section 260533 for raceways, Section 260519 for conductors and wiring, Section 260534 for outlet boxes, and Section 260529 for supports. System cabling requirements shall meet manufacturer standards.

D. Open cabling methods may be utilized above accessible ceilings. All cabling in exposed areas, above inaccessible ceilings and in walls shall be installed in raceway.

E. Control: The system shall have control devices to perform automatic and/or manual control functions indicated on the drawings and defined below. The control devices shall be capable of being controlled by any system input device type . The system shall also be capable of providing sequence of operations functions indicated on the drawings.
    1. Occupancy Sensor Control: Provide occupancy sensors for on/off control with manual dimming of light fixtures in as indicated on drawings. Control shall function as vacancy sensors with Manual-ON functionality or occupancy sensors with Automatic–ON functionality.
    2. Dimming Control Requirements: Provide automatic dimming for each light fixture in daylight areas and manual dimming zones as indicated on lighting zone control drawings.
    3. Manual On/Off Control: Provide control devices to turn on/off all light fixtures within manual control zones as indicated in the drawings.
    4. Daylighting Control Requirements: Provide daylight-responsive automatic control in all spaces where daylight contribution is available as defined by relevant local building energy code. See lighting control zone drawings for additional information:
        a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylighting zones.
        b. Daytime set points for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with drawings and specifications.

c. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system shall be designed to turn off electric lighting when daylight is at or above required lighting levels. Daylighting control system shall turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

5. Timeclock Control Requirements: Provide astronomical timeclock for on/off control based on time of day as indicated in drawings.
6. Plug Load control requirements: Provide control devices to energize/de-energize controlled receptacles as indicated in the drawings. Controlled receptacles are non-essential plug loads in spaces as required by the applicable energy code.

2.03 SYSTEM OPERATION

A. Digital Control System shall include the following features:
1. Occupancy Sensors: Digital wall/ceiling device or digital wall switch.
a. Calibration and configuration for the following variables:
1) Sensitivity: 0-100 percent in 10 percent increments.
2) Time delay: 1-30 minutes in 1 minute increments.
3) Test mode: Five second time delay.
4) Detection technology: PIR, Dual Technology activation and/or re-activation.
5) Walk-through mode.
b. Programmable control functionality including:
1) Each sensor may be programmed to control specific loads within a local network.
2) Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
3) On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use one of both technologies. Technologies include:
a) Ultrasonic or Microphonic.
b) Passive Infrared.
c. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal Hours (NH) and After Hours (AH) time periods.
d. Cable or wiring connections as required by the lighting controls systems.
e. Device Status LEDs including:
1) PIR detection.
2) Ultrasonic or Microphonic detection.
3) Configuration mode.
f. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
g. Manual override of controlled loads.
2. Dimming Control:
a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.

b. The following dimming attributes may be changed or selected using a network interface or wireless configuration tool:
   1) Establish preset level for each load from 0-100 percent.
   2) Set high and low trim for each load.
   3) Normalize dimming curve for main ambient light fixtures of each space so they dim at the same rate.
c. Override button(s) for each load provides the following functions:
   1) Press and hold for dimming control (Dim Up).
   2) Press and hold for dimming control (Dim Down).
d. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.

3. Daylight sensors:
   a. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
      1) Closed loop sensors measure the ambient light in the space and control a single lighting zone.
      2) Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
      3) Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.
4. Plug Load Control:
   a. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
   b. Default operation is Auto-on/Auto-off, based on timeclock signal for building hours of occupancy.
5. Digital Push Button Switches:
   a. Programmable control functionality including:
      1) Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
      2) Individual button function may be configured to Toggle, On only or Off only.
      3) Individual scenes may be locked to prevent unauthorized change.
      4) Ramp rate may be adjusted for each dimmer switch.
      5) Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
      6) Button priority may be configured to any priority level corresponding to system operation allowing local actions to utilize life safety priority.
      7) Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
6. Device Status LEDs to indicate:
   a. Data transmission.
   b. Device has power.
   c. Status for each load.

d. Configuration status.

7. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a. Turn on to 100 percent.
   b. Turn off.
   c. Turn on to last level.
8. Each load be configurable to operate in the following sequences based on occupancy:
   a. Auto-on/Auto-off.
   b. 50% Auto-on/50%Manual-on/Auto-off.
   c. Manual-on/Auto-off.

B. Analog Control Devices shall include the following features:
1. Wall Occupancy Switch:
   a. Manual On/Manual Off push button.
   b. Dimmable push buttons with 0-10V dimming where indicated.
   c. The following sequence:
      1) Time delay: 1-30 minutes in 1 minute increments.
      2) Test mode: Five second time delay.
      3) Detection technology: PIR, Dual Technology activation and/or re-activation.
2. Wall Switch with ceiling occupancy sensor and power packs:
   a. Manufacturers: Sensor Switch, Watt Stopper, Leviton, Hubbell, or approved.
   b. Manual On/Manual Off momentary contact push button.
   c. Dimmable push buttons with 0-10V dimming where indicated.
   d. Sensors capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
   e. Sensors dual technology which use passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound not acceptable.
   f. Coverage of sensors remains constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
   g. Sensors readily accessible with user adjustable settings for time delay and sensitivity.
   h. Include bypass manual override on each sensor in event of failure. When bypass is utilized, lighting shall remain on constantly or control shall divert to wall switch until sensor is replaced. Control recessed to prevent tampering.
   i. Include LED as continuous visual means of indication to verify that motion is being detected during both testing and normal operation.
   j. Include internal additional isolated relay with NORMALLY OPEN, NORMALLY CLOSED, and COMMON outputs for use with HVAC control, data logging, and other control options.
   k. The following sequence:
      1) Time delay: 1-30 minutes in 1 minute increments.
      2) Test mode: Five second time delay.
      3) Detection technology: PIR, Dual Technology activation and/or re-activation.
   l. Control wiring between sensors and control units shall be Class 2, No. 18 through No. 20 AWG, stranded, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.

2.04 POWER REQUIREMENTS

A. Include 120 VAC power for each controller and power supply.

2.05 EQUIPMENT

A. Control Panels: Include power supply, relays, network equipment, dry contact inputs, dry contact outputs, 0-10V dimming modules pre-wired in a single NEMA 1 enclosure.

B. Room Controllers (controls 8 or fewer outputs in a single enclosure): Include power supply, relays, network equipment, dry contact inputs, dry contact outputs, 0-10V dimming modules pre-wired in a single NEMA 1 enclosure. If multiple controllers/devices or pieces of equipment are located in a single space/room, provide custom enclosure with voltage barriers to enclose all of the devices and equipment.

C. On/Off Control Relays: Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load mounted in lighting control panel.

D. 0-10V Dimming Controller: The 0-10 V output controller compatible with 0-10V dimming driver/ballast and mounted in lighting control panel. 0-10V output shall automatically open upon loss of power to the Controller to assure full light output from the controlled lighting.

E. On/Off/0-10V Dimming Control Module: On/Off and dimming to control one output or load.
   1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load.
   2. Dual Voltage (120/277 VAC, 60 Hz) capable rated for 3A total load used for single light fixture control.

F. Phase Dimming Controllers: Forward phase 120V dimming modules with network communication functionality.

G. Ceiling/Wall Occupancy Sensors: Features include the following:
   1. Finish White. Provide compatible wall plates with decorator opening.
   2. Sensors capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
   3. Detection technology: Dual Technology activation and/or re-activation.
   4. Time delay: 1-30 minutes in 1 minute increments.
   5. Test mode: Five second time delay.
   6. Coverage of sensors remain constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
   7. Sensors readily accessible with user adjustable settings for time delay and sensitivity.
   8. Include bypass manual override on each sensor in event of failure. When bypass is utilized, lighting shall remain on constantly or control shall divert to wall switch until sensor is replaced. Control recessed to prevent tampering.
   9. Include LED as continuous visual means of indication to verify that motion is being detected during both testing and normal operation.
   10. Include internal additional isolated relay with NORMALLY OPEN, NORMALLY CLOSED, and COMMON outputs for use with HVAC control, data logging, and other control options. Include additional auxiliary module if sensor doesn't have auxiliary contact.
   11. Provide additional detection devices as required for the space.
   12. Provide sensors that can function at the same mounting height as the light fixtures including but not limited to the following areas:
      a. Ceiling heights less than 12 feet.
      b. Open ceiling areas of two or more stories.
   13. Analog Devices with Power Packs shall use power packs capable of automatic on or manual on.

H. Wall Switch Occupancy Sensors:
   1. Finish White. Provide compatible wall plates with decorator opening.
   2. Capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
   3. Detection technology: Dual Technology activation and/or re-activation.
   4. Time delay: 1-30 minutes in 1 minute increments.
   5. Test mode: Five second time delay.
   6. Coverage of sensors remains constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
   7. On/Off push button.
   8. Dim up/Dim down push button with 0-10V Dimming.

I. Photo Sensors:
   1. Finish: White. Provide compatible wall plates or ceiling plates with decorator opening.
   2. Sensor's internal photodiode shall only measure light waves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers. Sensor light level range shall be from 1-6,553 foot-candles (fc).
   3. Closed loop digital photo sensors shall include the following additional features:
      a. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
      b. Automatic self-calibration, initiated from the photo sensor, a wireless configuration tool or a PC with appropriate software.
      c. Automatically establishes application-specific set points following self-calibration. For dimming operation, a sliding set point control algorithm with separate Day and Night set points shall prevent abrupt ramping of loads.
   4. Open loop digital photo sensors shall include the following additional features:
      a. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
      b. Automatically establishes application-specific set points following manual calibration using a wireless configuration tool or a PC with appropriate software. For dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

J. Digital Control Switches:
   1. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration.
   2. Finish: White. Provide compatible wall plates with decorator opening.

K. Plug Load Control: 120 VAC, 60 Hz rated for 20A total load. .
   1. Automatic Load Control Relay: UL 20 rating for receptacle control.
      a. Digital relay connected to lighting control system provides ON/OFF control of plug loads within a space/zone via a programmable control relay.

L. Timeclocks:
   1. Manufacturer: Compatible with Control Panel or approved.
   2. Description: Electronic, solid-state programmable type with alphanumeric display, astronomic feature, automatic daylight savings time reset, 100 hour capacity, carry over, two channel unless indicated otherwise, 24 hour and 365 day calendar, skip-a-day, manual HOA override. Appropriate enclosure suitable for installation.

3. Contact Rating: 20 Amp resistive/general purpose, 10 Amp electronic ballast (LED) unless indicated otherwise.

M. Exterior Photo Cell:
1. Manufacturers: Compatible with Lighting Control Panel or approved.
2. Description: Weatherproof, electronic photo diode to operate in temperature range of minus 30 F to plus 140 F. Light level range of 1.5 “on” to 6 foot-candles “off” with manually adjustable level slide for off and on levels. Time delay of 2-5 seconds minimum to minimize false operation. Conduit wired stem mounting. Manually adjustable level slide. Rating of 6 Amps electronic ballast (LED) at rated Voltage. Compatible with lighting control system.

N. Contactors:
1. Manufacturer: Square D 8903 Series or equivalent by ASCO, Eaton/Cutler Hammer, GE, Siemens or approved.
2. Description: Electrically operated and mechanically **or** electrically held type of types, sizes, and ratings as indicated in the Contract Drawings, 30 Amp, 6-pole minimum. Include auxiliary devices and contacts as indicated on the Contract Drawings, two normally-open contacts minimum. Appropriate enclosure listed for installation.
3. Short Circuit Withstand (SCCR) Rating: Equal to or exceeding the available fault current at the upstream panelboard.

O. Network Communication Equipment: System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies. Hardware compatible with lighting controls systems that provides the following functions:
1. Facilitation of global network communication between different areas and control zones.
2. Time-based control of downstream wired and wireless network devices.
3. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
4. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
7. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 Wired connection.

P. Emergency Lighting Control Equipment:
1. Manufacturers: digital lighting control mfg or approved.
2. Equipment:
a. Fixture mounted automatic load control relay: UL 924 listed control relay factory mounted in light fixture. Refer to Section 265100 for additional requirements.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, A/E, Commissioning Agent, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.

B. Review installation procedures and coordination required with related Work and the following:
   1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
   2. Review the specifications for low voltage control wiring and termination.
   3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
   4. Review interface with Division 23 Controls including list of BACnet integration points, schedules and responsibilities.
   5. Discuss requirements for integration with other trades.

C. Inspect and make notes of job conditions prior to installation:
   1. Record minutes of the conference and provide copies to all parties present.
   2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.

3.03 PRE-INSTALLATION TRAINING

A. Prior to installation, post submittal, the manufacturer shall provide an on-site training session for the contractor. This is a mandatory meeting for the installing contractor to attend and is to be scheduled by the contractor. Notify A/E two weeks prior to meeting date. Manufacturer to provide agenda and Contractor to provide meeting minutes and attendance list.

3.04 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.05 INSTALLATION

A. Install system in accordance with the drawings, this section, Sections 260511, 260519, 260553, 262726, applicable codes and manufacturer's recommendations. Install wiring in compliance with NEC for power and non-power limited signaling circuits. Upon completion, certify in writing to the Owner and general contractor that system has been installed in compliance with NEC.

B. Lighting Control Equipment:
   1. Room Controllers/Control Panels: Install where indicated on the plans. Provide 120V power supply and circuit as indicated on the plans, if no circuit is indicated circuit with load on relay 1.
   2. On/Off/0-10V Control Modules:
      a. Remote Modules: Install remote mounted control modules in accessible location. Where possible mount to junction box connected to first light fixture in the lighting control zone.

b. Centrally located Control Modules: Two or more control modules mounted in a single location, install control units in a single enclosure with voltage barriers.

3. 0-10V Dimming Controllers: Install in room controllers/control panels where possible. Mount in NEMA 1 enclosure above entry doorway into space and in an accessible location where modules are providing control.
4. Phase Dimming Controllers: Install in electrical rooms.
5. Ceiling/Wall Occupancy Sensors: Install where indicated on the drawings and as required to provide complete coverage based on shop drawings layouts.
   a. Open to structure overhead sensors mount at same height as light fixtures.
6. Wall Switches: Mounting height to match switches in Section 260519.
7. Photo Sensors: Mount per manufacturer recommendations in locations indicated on shop drawings.
8. Network Communication Equipment: Install in main electrical room

C. Digital devices: Connect together with manufacturer approved low voltage network wiring.
   1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
   2. Low voltage wiring topology must comply with manufacturer's specifications.
   3. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

D. Test conductors for ground conditions before making final wiring connections. Comply with requirements in Section 260526.

E. Maintain wiring color code throughout installation. Include color code identification in the Operation and Maintenance Manual.

F. Coordinate with appropriate subcontractors for installation of equipment and devices that pertain to other work in the contract.

G. Clean dirt and debris from inside and outside of the equipment after completion of installation.

H. All line voltage connections shall be tagged to indicate circuit and switched legs.

I. Test all devices to ensure proper communication.

J. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

K. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting set points.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.).
   3. Load Parameters (e.g. blink warning, etc.).
   4. Normalized dimming in lighting control system to match dimming curve of each space main ambient light fixtures.

L. Post Start-up Tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy.

M. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

N. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

O. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to controllers.

3.06 INTERIOR LIGHT LEVEL SET POINTS

A. Light Levels: Measurements shall be made in accordance with the methods set forth in Section 9.15 of the IES handbook, 10th Edition.
   1. Measure all spaces/areas identified with a light level set points.
   2. Set dimming level of light fixtures so the maximum light output matches the light level set point.
   3. Photo sensors:
      a. Daylight Zones:
         1) Automatic dimming of light fixtures in primary/secondary daylight zones to maintain illumination levels indicated on Contract Drawings.
         2) Automatically turn off light fixtures when daylight illumination exceeds maintained illumination levels.
         3) Light fixture shall dim to driver/ballast lowest rated light output prior to switching off.
      b. Non-Daylight zones:
         1) Automatic dimming of light fixtures in control zones to maintain light level set point indicated on Contract Drawings.

3.07 OCCUPANCY SENSOR SETTINGS

A. Ceiling and wall mount occupancy/vacancy sensor time delay settings of 20 minutes except spaces below or indicated otherwise in the drawings:
   1. Public Restroom – Shall be adjusted to 15 minutes.
   2. Corridors – Shall be adjusted to 30 minutes.
   3. Offices/Conference Rooms – Shall be adjusted to 15 minutes.
   4. Work/Storage/Custodial Spaces – Shall be adjusted to 5 minutes.
   5. IDF/MDF Rooms – Shall be adjusted to 30 minutes.

3.08 EXTERIOR PHOTOCELL INSTALLATION

A. Mount on building roof facing north, away from spill light influence.

B. Set for appropriate on and off foot-candle levels.

3.09 EMERGENCY LIGHTING CONTROL EQUIPMENT INSTALLATION

A. Light fixture mounted Emergency Control Equipment:
   1. Factory Installed Devices: Verify that installation operates as intended on the Drawings. Perform necessary field adjustments.

B. Schedule simulated power outage with the Owner for verification of emergency light fixture operation.

3.10 IDENTIFICATION

A. Identify components, power and control wiring according to Division 26 Section "Electrical Identification”.

B. Identify controlled circuits in Directory Cards.

C. Provide engraved nameplate to identify time switches and contactors with a unique designation.

D. Provide engraved push buttons on digital switches, confirm switch labels with owner.

E. Provide printed labels on ceiling tiles or grid runners below all above ceiling mounted control devices.

F. Provide printed labels on Control Relays and modules to indicate controlled loads.

3.11 CONTRACTOR COMMISSIONING

A. Upon completion of initial contractor self-commissioning, the contractor shall coordinate system commissioning by the manufacturer's factory authorized representative who shall verify the system is complete and fully functional.

B. Provide computer generated documentation on the commissioning of the system with room by room description including:
   1. Sensor parameters, time delays, sensitivities, daylighting set points.
   2. Sequence of operations (e.g. Manual On, Auto OFF, etc.).
   3. Load Parameters (e.g. blink warning, etc.).
   4. Re-commissioning – After 30 days from occupancy, recalibrate occupancy/vacancy sensor time delay settings, occupancy/vacancy sensor sensitivity settings and photo sensor light level settings. Provide detailed report to A/E for review.

3.12 COMMISSIONING SUPPORT

A. Factory technician shall be on-site to support the enhanced commissioning process.

3.13 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.

B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
   1. Verify Class I and II wiring connections are terminated properly by validating system performance.
   2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
   3. Verify/complete task programming for all switches, dimmers, time clocks, and sensors.
   4. Verify that the control of each space complies with the Sequence of Operation.
   5. Correct any system issues and retest.

C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
   1. Date of test or inspection.
   2. Loads per space, or Fixture Address identification.
   3. Quantity and Type of each device installed.
   4. Reports providing each device's settings.

3.14 DEMONSTRATION AND TRAINING

A. Before Substantial Completion, arrange and provide a one-day (8 hour) Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instructions includes:
   1. Confirmation of entire system operation and communication to each device.
   2. Confirmation of operation of individual relays, switches, and sensors.
   3. Confirmation of system Programming, photocell settings, override settings, etc.
   4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

B. Provide additional one-day (8 hour) site visit for on additional training and site tuning 60-90 days after occupancy.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes wall switches, receptacles, device plates, box covers, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. Federal Specification W-C-596, Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
   2. Federal Specification W-S-896, Switch, Toggle.
   3. NEMA WD 1, General Color Requirements for Wiring Devices.
   4. NFPA 70, National Electrical Code (NEC).
   5. UL 498, Standard for Attachment Plugs and Receptacles.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data for each type of wiring device and appurtenance.

C. Test Reports:
   1. Field test reports.
   2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 WALL SWITCHES

A. Manufacturers: Leviton, Bryant Electric, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.

B. Finish: White.

C. Wall Switches for Lighting Circuits: NEMA WD 1. General use snap switch with colored toggle handle rated 20 Amps and 120/277 Volts AC. Switch with back and side wired screw type terminals. Units specification grade.
   1. Single-Pole Toggle Switch: Leviton Model 1221-2.
   2. Double-Pole Toggle Switch: Leviton Model 1222-2.
   3. Three-Way Toggle Switch: Leviton Model 1223-2.
   4. Four-Way Toggle Switch: Leviton Model 1224-2.

D. Pilot Light Type: Red pilot handle. Handle lighted when switch is ON. Rating same as for wall switches. Leviton Model 1221-PLR (120V)/1221-7PR (277V).

E. Lighted Handle Type: White pilot handle. Handle illuminated when switch is OFF. Rating same as for wall switches. Leviton Model 1221-LHW (120V)/1221-7LW (277V).

F. Momentary Contact Line Voltage Switches: Single pole, double throw, 3-wire, normally open. Rating same as for wall switches. Leviton Model 1257.

G. Weatherproof: Switches mounted in a cast metal box with gasketed, weatherproof device plate.

2.02 LED WALL DIMMERS

A. Manufacturers: Leviton, Lutron, Bryant Electric, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.
   1. Architectural Slide Dimmers:
      a. Leviton Model IP710-LF

B. Finish: White.

C. Voltage: 120 Volts.

D. Power Rating: Match load shown on the Drawings. 1200 Watts @ 120V and 1500 Watts @ 277V minimum.

E. Accessory Wall Switch: Match dimmer appearance.

2.03 LOW VOLTAGE CONTROL

A. Manufacturer: General Electric, Square-D, Cutler Hammer, Siemens, or approved.
   1. Relays: General Electric Type RR-7.
   2. Switches: General Electric Type RTS-5.
   3. Transformers: General Electric Type RT1 and RT2.
   4. Rectifiers: General Electric Type RA16.
   5. Device Plates: As specified in Article “Device Plates”.
   6. Finish: White.

B. Wire: Copper conductor for low voltage control purpose furnished by supplier of low voltage relays and switches.

2.04 RECEPTACLES

A. Manufacturers: Leviton, Bryant Electric, Crouse Hinds, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.

B. Finish: White.

C. Convenience and Straight-Blade Receptacles: NEMA WD 1. Units specification grade.

D. Convenience Receptacle Configuration: (20A-125V NEMA 5-20R) straight blade with grounding type with, back and side wired screw type terminals.
   1. Duplex Receptacle: Leviton Model 5362.
   2. GFCI Receptacles: Duplex convenience receptacle with integral ground fault circuit interrupter. Units feed-through type for downstream device protection. Leviton Model GFNT2.

E. Controlled Receptacle:
   1. Finish: Green
   2. Leviton Model 5362-S2N.
   3. Split Wire: Leviton Model 5362-S1N
   4. GFCI: Leviton Model 308-G5362-2TN

F. Weather Resistant Receptacles: Receptacles mounted in a cast steel box with gasketed, weatherproof device plate. Leviton GFWT2.

G. Specific Receptacle Configuration: NEMA WD 1. Type as indicated on the Drawings, with black plastic face.

H. Note: Designer to coordinate specific rating requirements and manufacturer options

2.05 DEVICE PLATES

A. Manufacturers: Bryant Electric, Hubbell, Leviton, Pass and Seymour, or approved. Bryant Electric and Leviton model numbers are listed.

B. Plates in Finished Areas: Type 302 non-magnetic stainless steel except as noted below:
   1. Wall plates for isolated ground receptacles to be with 1/4 inch specially engraved black letters “COMPUTER ONLY”.
   2. Wall plates for dedicated receptacles with 1/4 inch specially engraved black letters “DEDICATED”.
   3. Wall plates for receptacles protected by a GFCI circuit breaker or feed through GFCI receptacle with 1/4 inch specially engraved black letters “GFCI PROTECTED”. Leviton 84003-G40.
   4. Wall plates for receptacles other than NEMA 5-20R with 1/4 inch specially engraved black letters which show ampere rating, voltage, and phase.

C. Plates on Surface Mounted Boxes: Sized to fit box without extending over sides of box.

D. Cast Metal Plates: Cast metal box. Steel plates with steel boxes and copper-free aluminum with aluminum boxes. Stainless steel screws.

E. Raised Sheet Steel Plates: 1/2 inch high zinc or cad-plated covers with surface mounted sheet steel boxes.

F. Weather Resistant Cover Plate:
   1. While In-Use Cover: Cast metal with hinged gasketed device covers. Leviton IUM1V-GY unless otherwise noted.
   2. Not In-Use Cover: Cast metal with hinged gasketed device covers. Leviton WM1V-GY, only where noted on contract drawings.

G. Finish of Attachment Screws: Match that of its respective device plate.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 WIRING DEVICE INSTALLATION

A. Install wiring devices in clean electrical boxes, free from excess building materials, dirt, and debris.

B. Install jumbo size plates for outlets in masonry walls.

C. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

D. Install devices and wall plates flush and level.

E. Fasten each device to outlet box at wall surface to bring receptacle flush with plate or for switch handle the proper distance through plate.

3.05 ORIENTATION

A. Install switches vertical with handle operating vertically, up position "ON". Install center at 44 inches above finished floor unless noted otherwise on the Drawings.

B. Install receptacles vertical with ground slot up centered at 18 inches above finished floor and 6 inches above counters.

C. Install exterior receptacles vertical with ground slot up centered at 18 inches above finished grade.

3.06 RECEPTACLE GROUNDING

A. Install bare bonding wire between receptacle grounding terminal and box. Plaster ear screws connecting frame to box not acceptable for grounding.

3.07 HANDICAPPED ACCESS

A. Comply with requirements of Washington State Handicapped Access Code.

3.08 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

B. Prior to energizing circuitry, test wiring devices for electrical continuity and polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes overcurrent protective devices for operation at 600 Volts and below, including circuit breakers and fuses as individual components in separate enclosures and for installation as integral components of switchboards and panelboards and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

C. Comply with NEMA and ANSI standards as applicable to construction and installation of overcurrent protective devices.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.

C. Shop Drawings: Include layouts of circuit breakers with spatial relationships to proximate equipment.

D. Closeout Submittals:

1. Written confirmation that all circuit breaker settings were adjusted to match the power studies final report.

E. Test Reports:

1. Field test reports.
2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.04 EXTRA MATERIALS

A. Fuses: For each type and rating, furnish additional fuses amounting to 1 unit for every 5 units installed, but not less than 2 units of each size and type.

B. Spare Fuse Cabinet: Provide one, sized to house spare fuses provided under this contract plus 25% additional space for future.

C. Electronic Trip Unit Test Set: Furnish one set, including associated software, capable of testing each circuit breaker type.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Circuit Breakers: Square D, Eaton/Cutler Hammer, General Electric, Siemens or approved. Circuit breaker manufacturer shall be same as panelboard and switchboard manufacturer when installed therein.

B. Fusible Circuit Breakers: Bussmann Mfg. Co.

C. Fuses: Bussmann Mfg. Co. or Mersen Electrical Power. No substitutions. Fuses shall be by one manufacturer.

2.02 CIRCUIT BREAKERS

A. General:

1. UL 489 fixed mounted molded case type with unless indicated otherwise.
2. Overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication.
3. Common trip for two and three pole circuit breakers. Handle ties, manufactured by circuit breaker manufacturer, permitted for multi-wire branch circuits on approval of samples.
4. Trip ratings imprinted on handle or visible through deadfront cover.
5. Constructed for mounting and operating in any physical position and calibrated for operation in ambient temperature up to 40 C.
6. Mechanical screw type removable connector lugs, AL/CU rated, to accommodate conductors specified. Rated for 75 C conductors for 60 Amp and larger circuit breakers.
7. Amperage and Voltage as indicated.
8. Short circuit rating: RMS interrupting rating as indicated. Minimum 10,000 AIC rating at 120, 208 and 240 Volts. Minimum 14,000 AIC rating at 277 and 480 Volts.
9. Ground Fault Interrupter (GFI) circuit breakers: Equipped with integral ground fault interrupter set to trip on ground fault of thirty milliamps or greater.
10. Ground Fault Circuit Interrupter (GFCI) circuit breakers: Equipped with integral Class A ground fault circuit interrupter set to trip on ground fault of six milliamps or greater.
11. Arc Fault Circuit Interrupter (AFCI) where indicated.
12. Switching rated for 120 Volt and 277 Volt lighting branch circuits.
13. HACR rating where serving air conditioning and refrigeration equipment.
14. Current limiting, utilizing non-fuse type current limiting, where indicated.
15. Tandem-mounted circuit breakers not acceptable.
16. Minimum Frame Size: To match trip rating, unless indicated otherwise.
17. Keyed Interlocks: Externally-mounted and arranged to prohibit interlocked circuit breaker operation, except in a specified sequence. Include mountings and hardware. Provide nameplates at each keyed interlock indicating interlocked circuit breaker and sequence of operation.
18. Zone-Selective Interlocking: Integral with ground fault trip unit for interlocking ground fault protection function.
19. Arc Energy Reduction: Provide energy-reducing maintenance switch with local status indicator for use as a temporary arc-flash incident energy-reduction device during maintenance activities. Provide for each circuit breaker with a frame size 1200 Amps and larger and as indicated.
    a. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
    b. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
    c. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
    d. Provide dry relay contacts on each switch for annunciation of the switch position.

2.03 TRIP UNITS

A. General:
   1. Thermal magnetic unless indicated otherwise.

B. Thermal Magnetic Trip Unit: Adjustable magnetic trip setting for sizes 250 Amps and larger.

2.04 FUSES

A. General:
   1. Fuses of type, sizes, ratings, and electrical characteristics of single manufacturer.
   2. Fuses labeled UL Class L, UL Class R, current limiting, rated for up to 200,000 Amps.

B. Where fuses are shown on the Drawings feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing. Adjust fuse size and type to comply with manufacturer's recommendation.

C. Main Service, Feeder and Branch Circuit Fuses:
   1. For fuse ratings over 600 Amps: UL Class L (KRP-C or A4BY).
   2. For fuse ratings up to 600 Amps: UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R).
   3. Feeder or branch circuit directly feeding motors, transformers, and other inductive load: UL RK5 time delay (FRN-R, FRS-R or TR-R or TRS-R).
   4. Other Branch Circuits: UL Class RK1, (KTN-R, KTS-R or A2K-R, A6K-R).

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 CIRCUIT BREAKERS

A. Install in panelboards, switchboards and enclosures, in accordance with the manufacturer's recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards.

B. Install handle ties for multiwire branch circuits per Section 260519.

C. Device Settings: Adjust in accordance with the Electrical Power Studies report from Section 260573, including but not limited to the following:
   1. Circuit Breakers.
   2. Zone selective interlocking.

3.05 FUSES

A. Install fuses in switches, panelboards, switchboards and enclosures. Install fuses so current rating is visible from front when cover is open.

B. Do not install until equipment is ready to be energized.

C. Coordinate with equipment furnished by others for proper fuse type and size.

D. For motor and equipment circuits, fuse sizes shown on the Contract Drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) for nuisance free tripping. Adjust fuse size for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times.

3.06 FIELD QUALITY CONTROL

A. Test circuit breakers as specified in Section 260810.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes disconnect switches, enclosed circuit breakers and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 98, Enclosed and Dead-Front Switches.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of equipment and appurtenance. Include equipment characteristics such as ratings, enclosure type, dimensions and weight.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Disconnect Switches and Enclosed Circuit Breakers: Square D, Eaton/Cutler Hammer, General Electric, Siemens, or approved.

2.02 GENERAL

A. Ratings: Voltage, Amperage and horsepower rating suitable for circuit and equipment controlled. Service entrance rated where indicated or required.

B. Enclosures: Surface-mounted.
   1. NEMA Type 1, in general.
   2. NEMA Type 3R where exposed to moisture and where shown on the Drawings.

C. Accessories:
   1. Padlockable in "OFF" position.
   2. Labeled "ON"/"OFF" position.
   3. Ground lug.
   4. Neutral lug where applicable.
   5. Other accessories as indicated.

D. Nameplates: Per Section 260553.

2.03 DISCONNECT SWITCHES

A. General: Heavy duty, UL 98, horsepower rated with external handle.

B. Interlock: Defeatable door interlock that prevent door from opening when operating handle is in "ON" position.

C. Fusible or non-fusible as indicated. Fuse rejection clips where Class R fuses are specified.

D. Quick-make, quick-break mechanism. Visible blades.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Comply with applicable requirements of NEC, NEMA and NECA standards, and with recognized industry practice. Where these may be in conflict, the more stringent requirements govern.

B. Install where indicated on the Contract Drawings and where required. Mount independent of equipment served; do not attach to equipment served.

C. Coordinate installation work with electrical raceway, wire, and cable work as necessary for proper interface. Comply with requirements in Section 260533.

D. Install within sight of equipment or controller served.

E. Where locations are not shown on Contract Drawings, locate on wall adjacent to equipment being served or on formed steel channel frame at face of equipment. Coordinate location to maintain equipment clearances.

3.04 FIELD QUALITY CONTROL

A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes motor controls for electrical motor driven equipment and associated appurtenances. Refer to Section 260511 for electrical mechanical coordination and responsibilities.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work of this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Code and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. UL 98, Enclosed and Dead-Front Switches.
   3. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
   4. UL 508, Industrial Control Equipment.

C. Comply with NEMA for appropriate size of motor protection. For units not using NEMA rating, use equivalent NEMA size.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: For each type and size of motor controller and appurtenance.

C. Shop Drawings: Wiring diagrams for each type and size of motor controller.

1.04 SPARE MATERIALS

A. Include one spare starter coil for each starter size specified.

1.05 MOTOR VOLTAGE INFORMATION

A. Voltages available: 115, 240 Volt, single phase and 240 Volt, 3 phase.

B. Circuits designed (in general) for Motors as follows:
   1. Smaller than 3/4 HP: 115,240 Volts, single phase.
   2. 3/4 HP and Larger: 240 Volts, 3 phase.

C. Verify motor sizes and voltages provided under other divisions and notify the A/E if any discrepancies are noted.

PART 2 PRODUCTS

2.01 GENERAL

A. Size starters as indicated on the Drawings and specified in this section. Coordinate starter sizes with associated motors and furnish starters matched to motor horsepower.

2.02 MANUFACTURERS

A. Manufacturers: Cerus Industrial Building Automation Starter, Square D, Eaton/Cutler Hammer, General Electric, Siemens, Allen-Bradley, or approved.

2.03 MOTOR STARTERS

A. Manual Motor Starter: Horsepower-rated toggle switch type, lockable in the “OFF” position, with melting alloy overload relays, red “running” pilot light, nameplate and enclosure. Square D, Class 2510 or equivalent.
   1. Enclosures: Surface-mounted, NEMA 1 enclosure for indoor and NEMA 3R for locations subject to moisture, unless indicated otherwise.
   2. Acceptable for single-phase motors of 1 horsepower and smaller. Not acceptable for 3 phase motors.

B. Pushbuttons, Selector Switches, Pilot Lights, and Similar Devices: Include “HAND”, “OFF”, “AUTO” operation switch and watertight and dust-tight LED pilot lights for “HAND”, “OFF”, “AUTO”, “RUN”, and “OVERLOAD” conditions.

C. Overload Relays: Electronic solid state, sized for nameplate ampacity of motor served.

2.04 ADDITIONAL FEATURES

A. Include the following features to meet design performance:
   1. Over and under voltage and phase monitoring, field adjustable for over and under voltage levels. Include time delay before returning to normal operation after trip occurrence.
   2. Measure and display output current on front cover.
   3. Monitor and calculate power consumption (kWh) of motor load and display kW and kWh. Include pulse output (kWh) or 4 to 20 mA analog signal (kW) to automation system to monitor power consumption.
   4. Communication to automation system over BACnet MS/TP to report starter mode, terminal input status, run status, and fault status, voltage, current, power factor, kW, and kWh.

B. Power Factor Correction: Include capacitors for motors 25 horsepower and larger. Size to bring power factor to within range of 0.9 to 0.95. Capacitors fused type with blown fuse indicators mounted on front of starter enclosure. Include discharge resistors when required by NEC.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 MOTOR CONTROLLER INSTALLATION

A. Install generally in location shown on the Drawings with exact location chosen to provide necessary code clearances and to preserve maintenance access.

B. In finished areas, install motor protection switches flush and provide suitable stainless steel coverplates.

C. Install on steel frame anchored to the structure adjacent to, but independent of equipment served. Do not fasten to motor, mechanical equipment enclosure, or related supports.

D. For roof-mounted equipment, coordinate supports with architectural and structural to maintain roof integrity. Submit shop drawings.

E. Check for proper motor rotation and reconnect conductors as necessary to provide proper rotation.

F. Comply with requirements in Section 260553 for nameplates.

G. Install fuses in fuseholder so fuse size is visible.

H. Prior to air and water system balancing, verify overload relays match motor nameplate rating. After balancing, adjust overload settings to match actual motor current.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes interior and exterior luminaires, lamps, ballasts/drivers and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, and Sections 260500, and 260510 apply to Work in this section.

C. Comply with requirements in other specification sections for concrete used for embedding poles, pole foundations, and footings for exterior area luminaire poles, standards, and foundations. Pole bases included in this section.

D. Where conflict occurs, the Luminaire (Light Fixture) Schedule shall take precedence.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards: NFPA 70, National Electrical Code (NEC), including local amendments, as applicable.

C. Comply with NEC and NEMA for installation and construction of luminaires. Components, Devices and Accessories shall be listed and labeled for intended use as defined in NEC, by a qualified testing agency and acceptable to the AHJ. Luminaires shall be UL listed and be labeled.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

E. Each lamp type shall be of the same manufacturer.

F. Each ballast type shall be of the same manufacturer.

G. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

H. Luminaires in damp or wet locations shall be listed for such use and labeled as either "Suitable for Damp Locations" or "Suitable for Wet Locations".

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of luminaire and appurtenance.

1. Submit product data for associated lamp, ballast (or driver) for each luminaire type.
2. Create a matrix encompassing all luminaire types with ballast and lamp type, including manufacturer name and part number(s).
3. Submit copy of individual and/or tandem warranties for luminaire, lamp and ballast (or driver), as applicable.
4. For solid state lamps:
    a. Provide IES LM-79 report.
    b. Provide IES TM-21 report.

c. Provide Bin Coding System Chart, with appropriate target CCT reference line, identifying which bin corresponds to the lamps supplied to each luminaire. For luminaires with multiple solid state lamps, identify which bins shall be included for color mixing.

C. Qualifications: Indicate manufacturer qualifications as identified in Part 2.

D. Shop Drawings:
1. Submit dimensioned drawings of each type of luminaire. Submit in booklet form with separate sheet for each luminaire, assembled by luminaire "type" in alphabetical order with proposed luminaire and appurtenances clearly indicated on each sheet.
2. Submit support and hanging details for luminaires weighing more than 56 pounds and pendant hung luminaires requiring support design approved by the AHJ.
3. Submit copy of manufacturer installation instructions for each luminaire type.

E. Test Reports:
1. Comply with commissioning requirements in Section 260810.
2. Perform field test reports.
3. Submit completed copy of reports at the time of substantial completion. Include copy in the Operation and Maintenance Manual.

1.04 EXTRA MATERIALS

A. Turn over to the Owner and obtain signed receipt.

B. Include copy of transmittal(s) and receipt(s) in Operation and Maintenance Manual.

C. Lamps:
1. Furnish five percent (but not less than one solid state lamp) of solid state lamps for each type used on the project that has replaceable components.

D. Drivers:
1. Furnish two percent (but not less than one driver) of solid state drivers/power supplies for each type used on the project.

E. Exit Signs: Furnish and install ten percent (but not less than one exit sign) of each type used on the project. For each exit sign, include rough-in and fifty feet of branch circuit raceway and wiring connected to a local (non-emergency or emergency) circuit, as appropriate or indicated by AHJ. Location of spare exit signs as required/directed by AHJ.

1.05 DEFINITIONS

A. CU: Coefficient of utilization.

B. HID: High-intensity discharge.

C. HO: High output.

D. IC: Insulation contact.

E. Lamp: The complete light source package, including all associated components (base, pins, filament, outer bulb, solid state components, etc.) that make up a single unit.

F. Light: Radiant energy sensed or seen.

G. Light Fixture: Luminaire.

H. Lumens: Measured light output of lamp (or luminaire if using solid state lamping).

I. Luminaire: A complete lighting unit consisting of a lamp, ballast (or driver) as required together with the parts designed to distribute the light and to position and protect the lamp, as well as the electrical parts required to generate the light. This may include the means to connect to a power supply.

J. Rated Lamp Life:
   1. Incandescent, Fluorescent and HID lamps: The time after which half of the tested sample of lamps have extinguished.
   2. Solid State lamps: L-70, the time after which 70% of the initial lumen output is maintained out of the respective luminaire.

1.06 COORDINATION

A. Review luminaire types with respective ceiling type prior to ordering. Initiate a meeting with the ceiling installer and issue meeting minutes to the A/E. Inform A/E where mounting method conflict occurs.

B. Review luminaire types with location of building insulation prior to ordering. Initiate a meeting with the insulation installer and issue meeting minutes to the A/E. Inform A/E where non-IC rated luminaires are in conflict with the building insulation.

C. Review luminaire types with final millwork shop drawings. Initiate a meeting with the casework installer and issue meeting minutes to the A/E. Verify luminaires will fit where specified in or adjacent millwork prior to rough-in.

D. Coordinate layout and installation of luminaires and associated support methods with all trades.

E. Facilitate coordination meetings once a month (throughout construction) with the general contractor, ceiling installer, sprinkler installer, HVAC installer, plumber, telecommunications installer and all other applicable trades. Shop drawings shall be adjusted accordingly and resubmitted for A/E review and approval. Log shall be kept on site with meeting dates and meeting minutes.

F. Develop 3D shop drawings for coordination with other trades. Combine model with other trades for use during coordination meetings.
   1. Meet the requirements indicated in Division 01.

1.07 WARRANTY

A. Comply with requirements in Division 01 and Section 260500 – Warranty.

B. Warranty period as indicated in Section 260500 shall establish minimum requirement, unless otherwise noted.

C. Occupancy-Vacancy Sensors: 5 years.

D. Solid State Lamps and Drivers: 5 years.

E. Batteries (in luminaires or unit equipment): Manufacturer’s standard form in which manufacturer shall repair or replace components of rechargeable batteries that do not comply with minimum Code required life, within 5 years.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Housing: Metal parts shall be free from burrs, sharp corners and edges. Sheet metal components shall be formed and shall not warp or sag. Luminaires shall be free of light leaks while also providing the required ventilation so as not to degrade the rated photometric performance and rated life of lamps and/or ballasts. Adjustable luminaires shall utilize positive locking devices to set aiming angle; luminaire shall be able to be relamped without affecting aiming angle.

B. Lenses: Where utilized, acrylic plastic shall be 100% virgin acrylic, highly resistant to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation. Minimum thickness of 0.125 inches.

C. Hardware: Finish ferrous mounting hardware and accessories to prevent corrosion and/or discoloration to any and all adjacent materials. Hardware for steel or aluminum luminaires shall be cadmium, or approved, plated. Hardware for stainless steel luminaires shall be stainless steel. Hardware for bronze luminaires shall be stainless steel or bronze.

D. Sockets: Linear fluorescent lamp sockets shall be 4-position positive stop lamp-lock style with knife-edge contacts. HID sockets shall be porcelain for mogul or medium base lamps, pulse rated as required; sockets shall be keyed for all position oriented lamps.

E. Reflecting Surfaces: The following minimum reflectance values shall be met:
   1. White Surfaces: 85%.
   2. Specular Surfaces: 90%.
   3. Anodized Aluminum Surfaces: 93%.

F. Latches: Latches for luminaire doors/louvers, where applicable, shall be spring type and shall operate freely and easily without excessive force.

G. Wiring
   1. Cords/cables between luminaire components shall have a minimum temperature rating of 105°C.
   2. Cords/cables shall be fitted with appropriate strain relief connectors and/or weathertight entries, where required by application.
   3. No internal wiring shall be visible from normal viewing angles.
   4. Cords/cables to pendant luminaires shall match color of respective canopy.
   5. Internal and/or factory wiring shall be a minimum size of 18 AWG.

H. Installed Where Subject to Damage: Where luminaires are installed subject to physical damage and contain metal halide lamping, the luminaires shall consist of means of protection where the lamp is completely enclosed by glass or plastic/acrylic. If the lamp breaks, the glass shards shall not escape the luminaire and the lamp shall not emit ultraviolet light outside the luminaire.

I. Solid State LED luminaires shall be on at least one of the following (or be pre-approved by the A/E):
   1. U.S. Department of Energy Energy Star Qualified Luminaires Product List.
   2. Designlights Consortium Qualified Products List (where applicable category exists) or Lighting Design Lab LED Qualified Luminaire and Tubular LED Lamp List.

2.02 LAMPS

A. Refer to Luminaire (Light Fixture) Schedule for additional information.

B. Notify and send A/E manufacturer's recommendations for lamp/ballast combination if different from products specified.

C. Solid State:
   1. LED:
      a. Manufacturers:
         1) Minimum of 5 year history of producing and/or installing LEDs in North America.
         2) Philips/Lumileds, Osram/Sylvania, General Electric, Cree, Nichia, Samsung, or approved.
      b. Must be on U.S. Department of Energy Energy Star Qualified Lamps Product List.
      c. Must be on the Lighting Design Lab's LED Qualified Lamp List.
      d. Replaceable modules shall be designed to Zhaga Consortium standards.
      e. 4,000K CCT, unless otherwise noted.
      f. Minimum CRI of 85.
      g. Lamps shall not use any energy when 'off'.
      h. CCT throughout life of lamp shall be within +/- 200 K of respective specified value.
   2. Organic LED lamps are not allowed.

2.03 DRIVERS

A. Refer to Luminaire (Light Fixture) Schedule for additional information.

B. Notify and send A/E manufacturer's recommendations for lamp/ballast combination if different from products specified.

C. Quantities: For continuous linear light fixtures provide quantity of ballasts/drivers required to support the circuiting and control shown on the contract documents.
   1. Daylight zones: Provide drivers for control within daylight zones for linear fixtures that are mounted in any portion of a daylight zone. If 50% or more of a control length is in a daylight zone it shall be controlled within that zone.
   2. For linear lengths that cross primary/secondary zones control with the more stringent daylight zone.
   3. Control Length: Maximum eight foot, minimum four foot.

D. Solid State Drivers/Power Supplies:
   1. Manufacturers:
      a. Minimum of 5-year history of producing and/or installing drivers in North America.
      b. Philips/Advance, Osram Sylvania, General Electric, Universal, Thomas Research, or approved.
   2. When not in the luminaire, the housing shall be plenum rated.
   3. Poke-in wire trap connectors or integral leads color coded per ANSI C82.11.
   4. Withstand +/- 10% voltage fluctuation with no compromise of performance or life cycle.
   5. +/- 5% output across published load range.
   6. 120-277 Volt rating.
   7. PF greater than 0.9, at specified voltage.
   8. Minimum efficiency of 70% at rated full load.
   9. Maximum case temperature rating of 70°C.
   10. THD less than 20%.
   11. Class A sound rating.
   12. Minimum operating temperature of -20°F.

13. Shall tolerate sustained open circuit and short circuit output conditions without damage and without need for external overcurrent protection.
14. No PCB allowed.
15. Comply with ANSI/IEEE C62.41.1 & C62.41.2, Category A for transient protection.
16. Dimmable, as specified in the Luminaire (Light Fixture) Schedule.

2.04 EGRESS

A. UL 924 Listed.

B. Battery Packs (Emergency Ballasts) in General Luminaires:
   1. Manufacturers: Philips/Bodine, Iota Engineering, or approved.
      a. Solid State driver assemblies with integrated components are allowed.
   2. Must fit inside luminaire's ballast compartment. In case of remote ballast installation, battery pack shall be installed adjacent ballast and marked accordingly on the record drawings (as-builts).
   3. Must initiate within 3-10 seconds of power failure and allow for 90 minutes of operation.
   4. Compatible with 1-lamp, 2-lamp, 3-lamp, 4-lamp and dimming ballasts.
   5. Minimum 1,100 lumens of output for linear fluorescent lamps and 750 lumens for compact fluorescent lamps.
   6. Allow for multi-lamp operation.
   7. 120/277 Volt rating.
   8. End-of-lamp-life compatible.
   9. Damp listed.
   10. High temperature, maintenance-free nickel-cadmium sealed battery, minimum 7 years of operation.
   11. Self-testing, every 30 days, without horn. Indicator light shall flash if problem is detected.
   12. Must automatically switch back to normal power once available.
   13. Test switch, located inside the luminaire if possible; if not possible, notify A/E and locate switch and indicator light per A/E direction prior to rough-in.

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory. Work that requires modification due to unsatisfactory conditions, deemed by the A/E, shall be corrected and completed to the satisfaction of the A/E at no additional cost to the contract.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Temporary Lighting for Construction Use: Contractor shall provide lighting used during the construction period for construction tasks. Permanent luminaires that are part of the project may not be utilized for this use.

C. Temporary Lighting required as part of Project Phasing: As approved by A/E, permanent luminaires may be used for temporary lighting means. Install and energize the minimum number of luminaires necessary for the task. When construction is sufficiently complete, remove the temporarily installed luminaires in a neat and workmanlike manner, dissemble, clean thoroughly, replace lamp(s) and ballast(s) and install in permanent location per the contract documents. Permanently installed luminaires deemed by the A/E to be damaged shall be replaced at no additional cost.

D. Remote Mounting of Ballasts (where indicated on the drawings and/or approved by the A/E): Distance between the remote ballast and respective luminaire shall not exceed distance recommended by the ballast manufacturer. If recommended distance conflicts with the drawings, notify the A/E prior to rough-in.

3.04 INTERIOR LUMINAIRE INSTALLATION

A. Install luminaires at locations and heights as indicated on the Drawings, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NESC, NECA's "Standards of Installation", NEMA standards, and recognized industry practices to ensure that luminaires fulfill requirements. Luminaires shall be installed exactly level, secure and plumb with respective building lines. Wall mount and ceiling mount luminaires shall be securely and tightly attached to their respective mounting surface. Lay-in luminaires shall sit flush with grid ceiling system, doors shall swing completely open in the designed direction.

B. Luminaire Supports:

1. General: Comply with IBC and NEC (including all local amendments) as interpreted by AHJ for luminaires mounted in suspended ceilings. Lay-in and pendant luminaires shall not be supported by lay-in suspended grid ceiling system and must be attached to structure.
2. Support Requirements:
    a. Include flexible ball joint hangers for pendant and stem hung luminaires at designated points of support.
    b. Equip hooks used to hang luminaires with safety latches. Include supports, brackets, clips, screws and miscellaneous items for mounting luminaires.
    c. Include locking catches, screws, safety chain(s) or safety cable(s) for detachable luminaire parts, luminous ceiling accessories, louvers, diffusers, lenses and reflectors.
3. Seismic Restraints:
    a. For Luminaires Weighing Less than 10 Pounds: Install (1) slack No. 12 gauge hanger wire from luminaire to structure above.
    b. For Luminaires Weighing 10 to 56 Pounds: Install (2) independent slack No. 12 gauge hanger wires from opposite corners of luminaire to structure above.
    c. For Luminaires Weighing More than 56 Pounds: Support directly from the structure above by hangers approved by the AHJ. Comply with requirements in Section 260548 for seismic restraints.
    d. For Pendant Hung Luminaires: Support directly from structure with No. 9 gauge hanger wire or alternate support without using ceiling suspension system for direct support approved by the AHJ. Comply with requirements in Section 260548 for seismic restraints.

C. Fire Rated Assemblies: Provide gypsum board protection acceptable to the AHJ to ensure fire rating of ceiling or wall in which luminaires are installed. Maintain manufacturer's recommended ventilation requirements.

D. Provide backing in wall cavity to reinforce support for wall mounted luminaires.

E. Luminaire Contact with Building Insulation: When building insulation is installed at a location where contact with luminaires is unavoidable, IC-Rated luminaires shall be utilized. Where insulation is present and an approved IC-Rated luminaire is not available, provide a gypsum board assembly around the luminaire, maintaining all recommended ventilation requirements, to separate luminaire from adjacent insulation.

F. Protect installed luminaires from damage during construction period through date of substantial completion. Damaged luminaires, including associated components, shall be replaced in their entirety.

G. Installed in a Shower or Wet Location: If luminaires have exposed metal parts that are grounded, respective circuit breakers shall be GFCI. If luminaires have exposed metal parts that are not grounded, they shall not be utilized and an approved luminaire without exposed metal parts shall be provided. Inform A/E prior to ordering luminaires.

H. Exit Signs: Verify color of lettering with AHJ prior to ordering.

3.05 EXTERIOR LUMINAIRE INSTALLATION

A. Coordinate with work of other trades as necessary to properly interface installation of exterior lighting.

B. Wall Mount: Exterior building mount luminaires shall coordinate/align with building elements. Luminaires and respective mounting and rough-in means shall align in the center of building elements and shall not split unevenly across multiple elements. Notify A/E of conflicts prior to rough-in.

3.06 FIELD QUALITY CONTROL

A. Upon completion of installation of luminaires and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Repair malfunctioning units on site, then retest to demonstrate compliance. If not possible to repair on site, remove and provide new units and retest. Include copy of test reports in the Operation and Maintenance Manual.

B. Clean luminaires in their entirety of dirt and debris upon completion of installation, including but not limited to housing, lens(es), lamp(s) and louver(s) within (7) days of substantial completion.

C. At Substantial Completion, remove and provide new lamps in interior and exterior luminaires which are observed to be noticeably dimmed due to Contractor's use and testing, as judged by the A/E.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: The following sections apply to Work in this Division:

1. Section 260500 General Electrical Provisions
2. Section 260510 Basic Electrical Materials and Methods
3. Section 260511 Electrical Connections for Equipment
4. Section 260512 Electrical Demolition
5. Section 260519 Wire and Cables
6. Section 260529 Supporting Devices
7. Section 260533 Raceway Systems
8. Section 260553 Electrical Identification
9. Section 260534 Outlet Boxes

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Work includes the following:
   1. Structured Cabling System supporting various low-voltage systems
   2. Telecommunications Rooms and Spaces
   3. Grounding and Bonding Infrastructure
   4. Manufacturer Certification

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and 260500 sections apply to Work in this section.

1.02 RELATED SECTIONS

A. Related Sections
   1. 260500 – General Electrical Provisions
   2. 260510 – Basic Electrical Materials and Methods
   3. 260533 – Raceway Systems
   4. 260534 – Outlet Boxes
   5. 282300 – IP Security Video System

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:
   1. Installation Standards: Comply with following standards for cable and equipment installations. Publications shall be latest issue and addenda:
      a. NEC, National Electric Code.
      b. NESC, National Electric Safety Code.
      c. TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises.
      d. TIA-568-C.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
      e. TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
      f. TIA-568.3-D, Optical Fiber Cabling Components Standards.
      g. TIA-569-D, Commercial Building Standard for Telecommunications Pathways and Spaces.
      h. TIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Building.
      i. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises.
      j. TIA-758-B, Customer Owned Outside Plant Telecommunications Cabling Standard.
      k. TIA-862-B, Structured Cabling Infrastructure for Intelligent Building Systems.
      l. IEEE 802.3-2000. Ethernet Standard.
      m. BICSI Information Transport Systems Installation Methods Manual.
      n. BICSI Telecommunications Distribution Methods Manual.

2. Contractor shall have read the above documents and shall be familiar with the requirements that pertain to this installation. The documents may be obtained from:
   a. Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, http://global.ihs.com/
   b. BICSI, 8610 Hidden River Parkway, Tampa, FL, 33637, 800-242-7405, www.bicsi.org
3. Materials:
   a. UL listed and labeled. Install label to be visible.
   b. Equipment: Regularly catalogued items of manufacturer and supplied as complete unit in accordance with manufacturer's standard specifications with optional items required for proper installation unless otherwise noted in this section.
   c. Telecommunications connectivity and cabling independently tested to meet current TIA standards.

C. Qualifications:
1. Contractor performing work specified in this section is required to have special skills obtained by education, experience, or both.
2. Contractors bidding work specified herein shall have a minimum of seven years of experience in the construction, testing, and servicing of systems of the type and magnitude specified in this section.
3. Contractor shall be a certified installer of the telecommunications system and pre-qualified by the manufacturer for the purpose of offering the Applications Assurance warranty at the time of bid.
4. Contractor shall have direct access to the tools and test equipment required to complete the Work at the time of bid.
5. Project manager (in office) and superintendent (field) shall have 5 years of experience at project manager and superintendent levels, respectively, on completed telecommunications projects of like magnitude and complexity as to this project. Project manager shall be certified as a Registered Communications Distribution Designer (RCDD) through Building Industry Consulting Service International (BICSI).
   a. RCDD shall be a direct employee of the company bidding on said Work.
6. Field technicians who will work independently at any given time during the project on the structured cabling system shall have a minimum of 3 years' experience on completed telecommunications projects of like magnitude and complexity as to this project. Field technicians working at job site shall have completed a copper technician installation training class conducted by the warranting manufacturer or BICSI.
7. Field technicians who will work independently at any given time during the project on the optical fiber systems shall have a minimum of 3 years' experience on completed telecommunications projects of like magnitude and complexity as to this project. Field technicians working at the job site shall have completed an optical fiber technician installation training class conducted by the warranting manufacturer or BICSI.

1.04 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.
1. Submit complete at one time. Partial product submittals are not acceptable and will be returned unreviewed.

B. Pre-Construction Submittal:
1. Product Data
   a. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.

b. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
c. Submit Product Data information sheets for coordination with item and model number.
d. Where more than one product is indicated on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
e. Submit network test equipment proof of calibration by manufacturer.
f. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:
    1) Manufacturer's certification to provide warranty
    2) RCDD certification
    3) Copper and optical fiber installation certification
    4) Approved manufacturer classes satisfactorily completed

2. Shop Drawings
    a. Submit Shop Drawings of telecommunications cabling systems.
    b. Coordinate with other trades prior to submittal and start of installation.
    c. Show exact routing of horizontal cabling for workstation distribution throughout building, and intrabuilding and interbuilding copper and optical fiber backbone cabling.
    d. Label workstation devices to identify cabling being terminated in telecommunications rooms and spaces.
    e. Prepare shop drawings using AutoCAD/ Revit software or as approved by the Owner. Submit shop drawings full size in PDF format.
        1) Project was created in Revit, AutoCAD files shall be extracted from the Revit model by the Contractor.

C. Test Reports:
1. Prepare test reports and submit to the Owner's Representative an electronic copy of the detailed test results, including overall test summary report.
2. Include a copy of the detailed test reports on flash drive in each Operation and Maintenance Manual.
3. Include a hard copy of the summary test sheets in each Operation and Maintenance Manual.
4. Submit electronic copies in PDF and LinkWare software formats, including LinkWare reader software.

D. Record Drawings:
1. Keep complete set of telecommunications drawings in job-site office updated within 3 days to show actual installation of cabling and equipment during construction.
2. Use of this set of drawings for recording as-built conditions.
3. Indicate where material, equipment, and system component are installed differently from that indicated on the Contract Drawings, clearly and neatly using ink or indelible pencil in color red during construction.
4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner's Representative for review and acceptance.
5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request (from architect) final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.

6. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
7. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.

E. Project Closeout:
1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
2. Provide project closeout documentation including but not limited to; test result documentation, Record Drawings, manufacturer warranty certificates and Operation and Maintenance manuals.

1.05 DEFINITIONS

Accessible ceiling: An area above acoustical ceiling tiles/grid (or lay-in type ceilings) with a readily accessible space. Gypboard ceilings with access hatches and open to structure spaces shall not be considered accessible ceilings

Administration: Methodology defining the documentation requirements of a cabling system and its containment, the labeling of functional elements, and the process by which moves, additions, and changes are recorded

Bonding: Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed

Cable: An assembly of one or more insulated conductors or optical fibers within an enveloping sheath

Cable run: Length of installed media, which may include other components along its path

Cabling: System of cables, cords, and connecting hardware

Channel: End-to-end transmission path between 2 points at which application-specific equipment is connected including test cords and patch cords for a maximum total distance of 328 feet (100 meters)

Connecting hardware: Device, or combination of devices, used to connect cables or cable elements

Consolidation point: Location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways

Cross-connection: Connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end

Demarcation point: Point where operational control or ownership changes

Equipment room: Environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect

Ground: Conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of earth

Horizontal cabling: Distribution media that connects the telecommunications outlet/connector at the work area and the first piece of connecting hardware in the horizontal cross-connect

Horizontal cross-connect: Group of connectors that allows equipment and backbone cabling to be cross-connected with patch cords or jumpers

Infrastructure (telecommunications): Collection of those telecommunications components, excluding equipment, that together provides basic support for the distribution of information within a building or campus

Local area network (LAN): Standard industry term for a network installation that serves a relatively small area (for example, structured cabling installation serving a building)

Main cross-connect: Cross-connect normally located in the (main) equipment room for cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables

Metropolitan area network (MAN): Data communications network that covers an area larger than a campus area and smaller than a wide area network

Modular jack: Female telecommunications connector that may be keyed or unkeyed and may have 6 or 8 contact positions

Outlet/connector (telecommunications): Connecting device in the work area on which a horizontal cable or outlet cable terminates

Patch cord: Length of cable with connectors on both ends used to join telecommunications circuits/links at the cross-connect

Patch panel: Connecting hardware system that facilitates cable terminations and cabling administration using patch cords

Pathway: Sequence of connections that provides connectivity between devices on a network or between networks on an internetwork; the vertical and horizontal route of the telecommunications cable; a facility for the placement of telecommunications cabling

Permanent link: Test configuration for link excluding test cords and patch cords for maximum total distance of 295 feet (90 meters)

Plenum: Compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system

Telecommunications Room: Enclosed architectural space for housing telecommunications equipment, cable terminations, and cross-connect cabling

Storage Area Network (SAN): Specialized high-speed network dedicated to the transport of data between storage devices and servers

Star topology: Network topology in which services are distributed from or through a central point

Telecommunications: Transmission, emission, and reception of signs, signals, writings, images, and sounds, that is information of any nature by cable, radio, optical, or other electromagnetic systems

Unshielded twisted pair (UTP): Cable made up of one or more pairs of twisted copper conductors with no metallic shielding; the entire assembly is covered with an insulating sheath (cable jacket)

Wireless access point: Stand-alone hardware device or computer wireless adapter with software that acts as a wireless communication hub for users of wireless devices to connect with each other and to bridge those devices to the cabled portion of the network

Wide area network (WAN): Data communications system that uses telecommunications circuits to link LANs that are distributed over large geographic distances

Wireless local area network (WLAN): Data communications system that uses using radio frequency technology, such networks transmit and receive data over the air, minimizing the need for wired connections; they combine data connectivity with user mobility

Work area (workstation): Building space where occupants interact with telecommunications terminal equipment

Work area cable (cord): Cable connecting the telecommunications outlet/connector to the terminal equipment

1.06 PRE-CONSTRUCTION MEETINGS

A. Telecommunications subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.

B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative.

1.07 MANUFACTURER CERTIFICATION

A. Structured cabling system shall be covered by an Extended Product and Application Assurance Warranty.
   1. Warranty shall cover passive telecommunications infrastructure copper and optical fiber connectivity and cabling products and performance from the date of installation registration, and will support existing or future applications.
   2. Approved manufacturer solution partner and warranty is:
      a. Berk-Tek/ Leviton Technologies – Limited Lifetime warranty
      b. CommScope Uniprise – 25 year warranty
   3. Installation practices shall follow the installation guidelines and procedures specified in the manufacturer certified installer training course and current TIA standards.
   4. Submit closeout documentation in accordance with the manufacturer warranty requirements to comply for acceptance of warranty.

B. Provide the original hard copy certificate for the Application Assurance Warranty to the Owner.

1.08 MATERIAL PROVISIONS

A. Deliver materials to the Owner under provisions of this section.

B. Contractor shall be responsible to provide a material transmittal for all materials being provided to the Owner as described herein and that are not permanently installed. Transmittal shall be signed by the Owner receiving the materials. Transmittal shall be included as part of the O&M manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Substitutions: The substitution of products shall not be considered under the terms and conditions of this Section.

2.02 COPPER HORIZONTAL CABLING

A. Category 6 UTP cabling for interior spaces:
   1. Horizontal cables shall be constructed from 23 AWG insulated solid bare copper conductors formed into four individually twisted pairs with a crossfiller center spline.
   2. Conductors shall have an impedance of 100Ω ±10% / 100m.
   3. Cables shall meet the most current technical characteristics of TIA-568-C standard.
      a. Wire map
      b. Length
      c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
      d. Near-end crosstalk (NEXT) loss 43.3dB/100m @ 250MHz
      e. Attenuation to crosstalk ratio far-end (ACRF) 24.8dB/100m @ 250 MHz
      f. Power sum Attenuation to crosstalk ration far-end (PSACRF) 21.8dB/100m @ 250MHz

g. Power sum-near-end crosstalk (PS-NEXT) 41.3dB/100m @ 250MHz
h. Return loss (RL) 20.5dB/100m @ 250MHz
i. Propagation delay (PD) (CMP) 72% nom, (CMR) 68% nom
j. Delay skew (DS) 45ns/100m max
k. Balance (LCL/TCL) 27.0dB/100m @ 200MHz
l. Balance (EL-TCTL) 9.0dB/100m @ 200MHz

4. Cables shall be NFPA 262 CMP (plenum) rated as specified herein, unless otherwise noted. Cable diameter shall not exceed 0.23 inches.
   a. Manufacturer Berk-Tek LANmark-1000 series:
      1) Yellow plenum rated, Part No. 10032090
      2) Blue plenum rated, Part No. 10032094
      3) Gray plenum rated, Part No. 10032026
5. Cables shall be UL1666 IEC332-1 CMR (riser) rated as specified herein, unless otherwise noted. Cable diameter shall not exceed 0.23 inches.
   a. Manufacturer Berk-Tek LANmark-1000 series:
      1) Yellow riser rated, Part No. 10032461
      2) Blue riser rated, Part No. 10032455
      3) Gray riser rated, Part No. 10032452

B. Category 6 UTP outside plant cabling for underground and exterior spaces:
1. Horizontal cables shall be constructed from 23 AWG insulated solid bare copper conductors formed into four individually twisted pairs with a crossfiller center spline and enclosed by a UV resistant polyethylene in the color black. Cable shall contain a gel-filled water resistant flooding compound.
2. Cable diameter shall not exceed 0.25 inches.
3. Conductors shall have an impedance of 100Ω ±10% / 100m.
4. Cables shall meet the most current technical characteristics of TIA-568-C standard.
   a. Wire map
   b. Length
   c. Insertion loss (Attenuation) 32.8dB/100m @ 250MHz
   d. Near-end crosstalk (NEXT) loss 38.3dB/100m @ 250MHz
   e. Attenuation to crosstalk ratio far-end crosstalk (ACRF) 19.8dB/100m @ 250 MHz
   f. Power sum attenuation to crosstalk far-end crosstalk (PSACRF) 16.8dB/100m @ 250MHz
   g. Power sum-near-end crosstalk (PS-NEXT) 36.3dB/100m @ 250MHz
   h. Return loss (RL) 17.3dB/100m @ 250MHz
   i. Propagation delay (PD) 62% nom
   j. Delay skew (DS) 45ns/100m max
5. Cabling shall be utilized per the NEC for use where pathways are routed within or below building slabs and foundations, in outside plant underground pathways and for aerial applications.
   a. Manufacturer Berk-Tek LANmark-6 OSP, Part No. 10139885

C. Category 6 UTP UL Listed cabling rated for indoor/outdoor applications:
1. Cabling shall be utilized per the NEC for use where pathways are routed within or below building slabs and foundations.
2. Horizontal cables shall be constructed from 23 AWG PO (non-plenum) insulated solid bare copper conductors formed into four individually twisted pairs with a core separator.

3. Cabling shall be fully water blocked with a flooded core and shall have a black sunlight resistant jacket.
4. Cable diameter shall not exceed 0.271 inches.
5. Conductors shall have an impedance of 100Ω ±10% / 100m.
6. Cables shall meet the most current technical characteristics of TIA-568-C standard.
    a. Wire map
    b. Length
    c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
    d. Near-end crosstalk (NEXT) loss 49/100m @ 250MHz
    e. Attenuation to crosstalk ratio (ACR) 6.7dB/100m @ 100MHz
    f. Power sum attenuation to crosstalk ratio (PS-ACR) 4.7dB/100m @ 250MHz
    g. Power sum-near-end crosstalk (PS-NEXT) 40dB/100m @ 250MHz
    h. Return loss (RL) 17.3dB/100m @ 250MHz
    i. Delay skew (DS) 25ns/100m max
7. Cabling shall be NEC rated CM for general purpose communications in accordance with Article 800 of the National Electrical Code (NEC.)
    a. Manufacturer Mohawk VersaLAN, Part No. M58772

2.03 OPTICAL FIBER HORIZONTAL CABLING

A. Horizontal 50/125 μm multimode optical fiber backbone cabling (OM3) shall be indoor/outdoor rated tight buffer cable utilizing a dry water blocking system with 900 μm buffered fibers surrounded by FGE/aramid yarns.
    1. Multimode optical fiber shall meet the following performance specifications.
        a. Maximum Attenuation: 3.0 dB/km @ 850 nm, 1.0 dB/km @ 1300 nm
        b. Minimum Bandwidth: Effective Model Bandwidth using Differential Mode Delay is 2000 MHz-km @ 850 nm; Overfilled launch is 500 MHz-km @ 1300 nm
        c. Gigabit Ethernet distances of 1000 m @ 850 nm, 600 m @ 1300 nm
        d. 10 Gigabit Ethernet distances of 300 m @ 850 nm, 300 m @ 1300 nm
        e. Numeric Aperture: 0.200 +/- 0.015
        f. Core Diameter: 50 +/- 2.5 μm
        g. Cladding Diameter: 125.0 +/- 1.0 μm
        h. Operating Temperature: -20C to +75C
        i. Storage Temperature: -40C to +85C
    2. Cable shall have an overall black color jacket and shall meet the following standards: Telcordia GR-409; ICEA S-104-696; ICEA S-83-596; ETL and OFNR (riser) rated as specified herein, unless otherwise noted.
        a. Manufacturer Berk-Tek, 2-strand riser rated, Part No. ATR002EB3010/25

2.04 INNERDUCT AND CABLE IDENTIFICATION TAGS

A. Textile Innerduct:
    1. Textile innerduct shall contain multiple flexible, polyester/nylon textile resin polymer fabric textile cells per innerduct as indicated on the Contract Drawings. Innerducts shall be installed within conduit raceways. Innerduct cells shall be the color white and shall have footage markers indicated on the side of the cell.
    2. Center spine of textile innerduct shall be installed in the color black or red when utilizing a 3-inch width. Black shall be the default color when only one set of innerduct is being installed within a conduit. Center spine of textile innerduct shall be installed in the color purple when utilizing a 2-inch width.

3. Cells within the textile innerduct shall contain a pull tape in differentiating colors. One cell shall have a pull tape in the color white, a second cell shall have a pull tape in the color white with a blue stripe and the third cell shall have a pull tape in the color white with an orange stripe.
    a. Manufacturer MaxCell:
        1) 2-inch, 2 cell with the color black spine, Part No. MXE52222BKyyyy (yyyy = length in feet)
        2) 3-inch, 3 cell with the color black spine, Part No. MXE64283BKyyyy (yyyy = length in feet)
        3) 3-inch, 3 cell with the color red spine, Part No. MXC64283RDyyyy (yyyy = length in feet)
4. Textile innerduct installation kits shall be provided for a single innerduct pack or multiple innerduct packs. Utilize an 1800 lbs. swivel device or a 2-way/ 3-way chain harness based upon the quantity of innerducts being installed within a conduit raceway.
    a. Manufacturer MaxCell:
        1) Single 1800 lbs. swivel, Part No. MXCSW600
        2) 2-Way chain pulling harness, Part No. MXC2CH
        3) 3-Way chain pulling harness, Part No. MXC3CH
5. Textile innerduct inflation termination bags shall be provided for each conduit. Inflation bags shall be provided in each outside plant conduit at the last maintenance hole that routes to either the associated telecommunications room or the exterior junction box on the building or structure. Inflation bags shall also be provided at the opposite end at the telecommunications room or the exterior junction box.
    a. Manufacturer MaxCell:
        1) 4-inch diameter Inflation Bag, Part No. MXCRTBVL100
        2) 3-inch diameter Inflation Bag, Part No. MXCRTBVL80
        3) 2-inch diameter Inflation Bag, Part No. MXCRTBVL50

B. Optical Fiber Flexible Plastic Innerduct:
1. Flexible duct/innerduct shall be UL 2024 with pull tape. Flexible duct/ innerduct shall be provided for all optical fiber cabling routed in open cabling pathways and backbone riser applications.
    a. Manufacturer Carlon:
        1) 1-inch plenum, Part No. CF4X1C-xxx (where xxx = feet)
        2) 1-1/4-inch plenum, Part No. CG4X1C-xxx (where xxx = feet)
        3) 1-inch riser, Part No. DF4X1C-xxx (where xxx = feet)
        4) 1-1/4-inch riser, Part No. DG4X1C-xxx (where xxx = feet)

C. Copper and Optical Fiber Identification Tags:
1. Identification tags shall be self-laminating, write-on, rigid, non-adhesive, measuring 3.50” x 2.00”, and with a vinyl material strength of 0.20”. Attach the tags to the associated innerduct or directly to the cabling utilizing specified cable ties. The legend and nomenclature for optical fiber cabling shall read “CAUTION: FIBER OPTIC CABLE” and for copper cabling shall read “CAUTION: TELEPHONE CABLE”. Each tag shall have sub attribute lines for “TYPE” and “COUNT”. The tag color for optical fiber cabling shall be yellow and the tag color copper cabling shall be orange.
    a. Manufacturer ACP International:
        1) Optical fiber cabling tags, Part No. VCT-200 (yellow)
        2) Copper cabling tags, Part No. VCT-201 (orange)

2. Cable tie shall be dome-top; barb type with stainless steel locking barb, material shall be Nylon 6.6 with a maximum width of .141”.
    a. Manufacturer Panduit or equal:
        1) 6.1-inch length, Part No. BT1.5I-C0
        2) 8.0-inch length, Part No. BT2I-C0

2.05 TELECOMMUNICATIONS WORKSTATION DEVICES

A. Category 6 Modules:
1. 8-Position 8-Conductor modules shall be Category 6, dual reactance technology, non-keyed, universal T568A/B pin configuration standard and used to terminate Category 6 UTP cables as specified herein. Module shall be high impact plastic housing, flame retardant UL 94V-O, modular contacts shall be beryllium copper, nickel plating under 50 micro-inches gold plating in contact area. IDC contacts shall be phosphor bronze, nickel under plating with tin lead over plate serving 22 through 24 AWG.
    a. Manufacturer Leviton:
        1) Category 6 module:
            a) White, Part No. 61110-RW6
            b) Ivory, Part No. 61110-RI6
            c) Black, Part No. 61110-RE6
            d) Gray, Part No. 61110-RG6
        2) Blank module in package of 10:
            a) White, Part No. 41084-BW
            b) Ivory, Part No. 41084-BI
            c) Black, Part No. 41084-BE
            d) Gray, Part No. 41084-BG
2. Ivory color, Augmented Category 6, 8P8C modules and blank modules shall be provided for installation of modules in surface mounted raceway.
    a. Manufacturer Leviton:
        1) Category 6 module, Part No. 61110-RI6
        2) Blank module (pkg. of 10), Part No. 41084-BI

B. Wall Phone Faceplate with Studs:
1. Wall phone faceplates shall be stainless steel single gang plates with top and bottom phone studs for mounting of telephony handsets. Provide 8P8C module in the category of infrastructure specified for the structured cabling system.
    a. Manufacturer Leviton, Part No. 4108W-1SP

C. Faceplates:
1. Faceplate shall be thermoplastic or stainless steel manufactured to hold 8P8C modules with recessed designation strips with clear plastic covers in accordance with the TIA-606-B labeling standard.
    a. Manufacturer Leviton:
        1) 4-port thermoplastic:
            a) White, Part No. 42080-4WS
            b) Ivory, Part No. 42080-4IS
            c) Black, Part No. 42080-4ES
            d) Gray, Part No. 42080-4GS
        2) 6-port thermoplastic:
            a) White, Part No. 42080-6WS

b) Ivory, Part No. 42080-6IS
c) Black, Part No. 42080-6ES
d) Gray, Part No. 42080-6GS

3) 4-port stainless steel, Part No. 43080-1L4
4) 6-port stainless steel, Part No. 43080-1L6

D. Surface Mount Boxes:
1. Surface mount boxes shall be thermoplastic to hold 8P8C modules with recessed designation strips with clear plastic covers in accordance with the TIA-606-B labeling standard.
a. Manufacturer Leviton:
1) 1-Port white, Part No. 41089-1WP
2) 1-Port ivory, Part No. 41089-1IP
3) 2-Port white, Part No. 41089-2WP
4) 2-Port ivory, Part No. 41089-2IP

E. Power Pole Bezel:
1. Bezel shall hold 8P8C modules and shall utilize a 106-type configuration.
2. Bezel shall be a color that matches the power pole; default color shall be Ivory.
a. Manufacturer Leviton, Part No. 41087-QIP

F. Floor Box and Poke-Thru Pedestal Frame:
1. Frame shall hold four 8P8C modules and shall utilize a Decora style configuration.
a. Manufacturer Leviton:
1) White, Part No. 41644-00W
2) Ivory, Part No. 41644-00I

2.06 DIRECT CONNECT AND ALARM CONNECTIVITY

~~A.~~ Direct Connect Connectivity and Terminations:
1. 8P8C Modular Plugs
a. Pre-approved Category 6 8-position, 8-conductor 8P8C plugs shall be provided based on the warranting manufacturer for the direct attach termination to solid conductor Category 6 cabling.
b. 8P8C plugs shall be compatible to be terminated on both Category 6 and Augmented Category 6 cabling.
c. 8P8C plugs shall be field terminated with manufacturer approved termination tool. No other termination tools shall be authorized for the termination of these direct attach terminations.
d. Plugs with a plastic boot shall be plenum rated when used in an air-plenum environment.
e. Adhere to manufacturer’s plug installation guidelines and testing procedures to ensure proper performance and signal transmission.
1) Category 6 8P8C plug approved manufacturers:
a) Bel Stewart, Part No. SS-39100-021
b) Sentinel, Part No. 111-08080054L34
c) Allen Tel, Part No. AT8X8RCSC-24
2) 8P8C termination tool approved manufacturers:
a) Bel Stewart, Part No. 2990003-01

b) Sentinel, tool & die set, Part No. 9000015 & 900216
c) Allen Tel, Part No. AT568 or AT680

B. Security Connectivity:
1. RJ31X surface mount device shall be provided for the security intrusion alarm panel. Surface mount device shall be pre-wired 8-position, 8-conductor RJ31X with shorting bar and screw terminals.
2. Device shall be mounted on wall/backboard adjacent to security panel or fire alarm panel. Route horizontal cabling from security device location to 110 cross-connect field in the telecommunications room. Terminate cable on last position of 110-field as noted on the drawing and label as “RJ31X”.
a. Manufacturer Leviton, Part No. 40278-SBI

2.07 TELECOMMUNICATIONS ROOM CONNECTIVITY

A. Patch Panels:
1. Category 6 Modular Patch Panels
a. Category 6, 8-Position 8-Conductor module, non-keyed, dual reactance technology, 110 type printed circuit board style patch panels, universal T568A/B pin configuration standard and used to terminate UTP cables as specified herein. Patch panels shall be high density, 6-port modules, panel shall be14-gauge steel with black painted finish; module shall be high impact plastic housing, flame retardant UL 94V-O, and fully encased protected printed circuitry. Modular contacts shall be beryllium copper, nickel under plating, 50 micro-inches of gold in contact area with IDC contacts phosphor bronze, nickel under plating with tin lead over plate, serving 22 through 26 AWG.
1) Manufacturer Leviton:
a) 24 port patch panel, Part No. 69586-U24
b) 48 port patch panel, Part No. 69586-U48

B. Wall Mount 110 Series Wiring Block:
1. 110 wiring blocks shall be constructed of high impact fire retardant polycarbonate UL 94V-O molded plastic and shall contain extension legs. IDC contacts shall be phosphor bronze, 90/10 tin lead plating. Each kit shall include white horizontal identification strips that secure and organize 25 pairs each. For backbone cabling terminations, utilize 5-pair 110C connecting clips only. Each block shall include legs to allow back cable routing. The wiring blocks shall accommodate 22 through 26 AWG cable conductor size.
a. Manufacturer Leviton:
1) Category 5e 100-pair backbone kit, Part No. 41AB2-1F5
2) Category 5e 300-pair backbone kit, Part No. 41AB2-3F5
3) Category 5e 100-pair horizontal kit, Part No. 41AB2-1F4
4) Category 6 96-pair horizontal, Part No. 41AB6-1F4

C. Optical Fiber Cabinets and Connectivity:
1. Optical fiber cabinet shall be a termination and administration point for the optical fiber cables. Cabinets shall protect the connectorized optical fiber from mechanical stress, macro-bending loss at the connection point and tampering with the circuits.
2. Surface Mount Fiber Cabinets (SMFC)
a. SMFC shall provide cross-connect and inter-connect capabilities and include support hardware to properly terminate and route the optical fiber strands and patch cords in a wall field.
b. SMFC shall have connector panels or adapters that can snap into the side of the interior vertical panel and accommodate optical fiber connectors.

c. SMFC shall be made heavy constructed 16 gauge laser cut steel with optional double sided lock for additional security.
    1) Manufacturer Leviton:
        a) One adapter SMFC, Part No. 5WMNT-1C
        b) Two adapter SMFC, Part No. 5WSML-2C
        c) Four adapter SMFC, Part No. 5WMED-4C
        d) Lock and key, Part No. 5L000-KAL (Qty. 2)

3. Rack Mount Fiber Cabinets (RMFC)
    a. RMFC shall accommodate terminating and splicing capabilities for optical fiber strands.
    b. RMFC shall be stackable, wall or rack mountable depending on the location requirement. The cabinets shall fit into either 19” or 23” frame arrangements and shall be one, two or four rack units in height.
    c. RMFC shall consist of an enclosure with front and rear access and can be fully administered from the front or rear.
    d. RMFC shall have a translucent, hinged Plexiglas door in the front and rear with sliding tray.
        1) Manufacturer Leviton:
            a) 1RU patching and splicing, Part No. 5R1UH-S03
            b) 2RU patching and splicing, Part No. 5R2UH-S06
            c) 4RU patching and splicing, Part No. 5R4UH-S12
    e. Fusion Splice Trays
        1) Fiber splice trays shall be offered with clear polycarbonate covers for viewing, and tie-down holes for securing incoming fiber. Trays shall accommodate 12 heat-shrink style splicing for both single-mode and multimode fiber.
            a) Manufacturer Leviton, Part No. T5LHS-P06

4. Optical Fiber Adapter Panels
    a. Optical fiber adapter panels shall be located within surface mount and rack mount fiber cabinets. Panels shall securing lock into open positions with the patching frames. Panels shall have plunger / grommet fasteners.
    b. Optical fiber adapter panels shall consist of ST, LC or SC connector types and shall be configured in either simplex or duplex connector arrangements and indicated in the Contract Documents.
    c. Unfilled positions within the fiber cabinets shall contain blank panels.
        1) Manufacturer Leviton:
            a) Blank adapter panel, Part No. 5F100-PLT
    d. 50μm multimode optical fiber connectors shall be color aqua, with phosphor-bronze alignment sleeves.
        1) Manufacturer Leviton:
            a) 6-Duplex LC 50μm, Part No. 5F100-2QL
            b) 3-Duplex SC 50μm, Part No.5F100-6QC
            c) 6-Duplex SC 50μm, Part No.5F100-2QC
    e. 62.5μm multimode optical fiber connections shall be in the color beige, with phosphor-bronze alignment sleeves.
        1) Manufacturer Leviton:
            a) 6-Duplex LC 62.5μm, Part No. 5F100-2IL

b) 3-Duplex SC 62.5μm, Part No.5F100-6IC
c) 6-Simplex ST MM, Part No. 5F100-6MT

f. Singlemode optical fiber connectors shall be in the color blue with ceramic alignment sleeves.
1) Manufacturer Leviton:
a) 6-Duplex LC SM, Part No. 5F100-2LL
b) 3-Duplex SC SM, Part No. 5F100-6LC
c) 6-Duplex SC SM, Part No. 5F100-2LC
d) 6-Simplex ST SM, Part No. 5F100-6MT

2.08 OPTICAL FIBER CONNECTIVITY

A. Optical Fiber Fan Out Kits
1. Buffer tube fan-out kits shall provide the means of field-install connectors on 250 µm coated fibers. Indoor kits shall have a 900 µm fan-out assembly that is color coded to match the fiber color scheme. The fan-out assembly shall be 47-inches in length.
a. Manufacturer Corning:
1) 6-fiber kit, Part No. FAN-BT47-06
2) 12-fiber kit, Part No. FAN-BT47-12

B. Multimode Connectors
1. Field installable multimode connectors shall be provided to terminate optical fiber cables from cable-to-cable, cable-to-equipment or equipment-to-equipment. Multimode connector shall contain a factory bonded fiber strand insert, ceramic ferrule and factory polished.
2. Connector shall be capable of mounting on either 0.9 mm-buffered fiber or 3.0 mm cordage. Connector shall meet IEC standards for repeatability and have a locking feature to the coupler and assure non-optical disconnect.
a. Manufacturer Leviton:
1) LC 50 μm, Part No. 49991-LLC
2) SC 50 μm, Part No. 49991-LSC
3) ST 50 μm, Part No. 49991-5ST
4) LC 62.5μm, Part No. 49991-MLC
5) SC 62.5μm, Part No. 49991-MSC
6) ST 62.5μm, Part No. 49991-MST

2.09 OPEN CABLING SUPPORTS

A. Accessories and mounting hardware shall be provided for securing supports to structure for a complete and working installation of open cabling supports. Supports shall comply with TIA requirements for structured cabling systems and pathway supports. Follow manufacturer's recommendations for quantity of cables supported.

B. Hook & Loop Fasteners:
1. Hook and loop fastener rolls shall be offered in 15 and 75-foot lengths and be 0.5-inch in width. Shear strength; for plenum rated product shall be 29 PSI and non-plenum rated product shall be 23 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
a. Manufacturer Leviton or equal:
1) Non-plenum 15' roll, Part No. 43115-15
2) Non-plenum 75' roll, Part No. 43115-75

3) Plenum 15’ roll, Part No. 43115-15P
4) Plenum 75’ roll, Part No. 43115-75P

C. Circular Cable Retainer:
1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
a. Manufacturer Erico Caddy, Part No. CAT CR50

D. J-Hooks:
1. J-hooks shall have a Galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
a. Manufacturer Erico Caddy:
1) 1” Dia., Part No. CAT16HP
2) 1-5/16” Dia., Part No. CAT21HP
3) 2” Dia., Part No. CAT32HP

E. Adjustable Cable Support:
1. Adjustable cable supports shall be of steel and polyethylene, plenum rated, with unlocking and locking bar allowing additional cables to be added easily after installation.
a. Manufacturer Erico Caddy, Part No. CAT425

F. Conduit Waterfalls:
1. Waterfalls shall be of glass reinforced flame retardant nylon 6.6 and UL Listed for air handling spaces (plenum).
2. Waterfalls shall be provided at the ends of 4-inch conduits and conduit sleeves installed horizontally where the pathways transition from conduit to ladder rack and cable tray pathways. Waterfalls shall be utilized to provide bend radius of all horizontal and backbone cabling.
a. Manufacturer Panduit, Part No. CWF400

2.10 FIRE-RATED PATHWAYS

A. Fire-rated pathway device shall consist of a corrugated steel tube with zinc coating, contain an inner plastic housing, intumescent material rings and tightly twisted inner fabric smoke seal. Intumescent firestopping material shall automatically adjust to the size of the cabling bundle and shall permit cabling to be added or removed without the need to remove the firestopping material through the adjustment of the flanges and device threads at the ends of each sleeve. After the installation of the cabling, twist the inner fabric smoke seal so that it seals around the cabling. Length of the sleeve shall be 12.4 inches. The pathway device shall be UL tested and classified in accordance with ASTM E814 (UL1479).
1. Manufacturer HILTI Speed Sleeve:
a. 2-Inch fire-rated pathway device, Part. No. 2097882
b. 4-Inch fire-rated pathway device, Part No. 2097883

B. Fire-rated pathway device shall consist of a heavy gauge galvanized steel raceway lined with intumescent firestopping material. The intumescent firestopping material shall automatically adjust to the size of the cabling bundle and shall permit cabling to be added or removed without the need to remove the firestopping material. Provide the necessary quantity of wall plates to support the pathway device. The pathway device shall be UL tested and classified in accordance with ASTM E814 (UL1479).
1. On the 3-inch and 4-inch sleeves, provide radius control modules at the end of each sleeve through wall transitions and penetrations.

a. Manufacturer Specified Technologies, Inc. EZ Path:
   1) 1.5-Inch fire-rated pathway device, Part No. EZD22
   2) 3-Inch fire-rated pathway device, Part. No. EZDP33FWS
   3) 3-Inch radius control module, Part No. RCM33
   4) 4-Inch fire-rated pathway device, Part No. EZDP44S2
   5) 4-Inch radius control module, Part No. EZRCM44S
   6) 4-Inch extension module, Part No. EZD44ES

C. Firestopping putty shall be a one-part, two-stage intumescent, non-hardening compound. The putty, when exposed to high heat or flame shall be capable of expanding a minimum of five times. Range of continuing expansion shall be from 230°F to >1,000°F (110°C to >538°C). The putty shall be soft and pliable with aggressive adhesion and shall not contain any water-soluble intumescent ingredients. The putty shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
   1. Manufacturer Specified Technologies, Inc. SpecSeal:
      a. 24” putty bar, Part No. SSP28
      b. 36” putty bar, Part No. SSP100

2.11 MATERIAL PROVISIONS

A. Materials shall be provided to the Owner as specified herein. Deliver to the Owner Representative 21 days prior to Substantial Completion. Include a signed transmittal to the Owner or Owner’s Representative for each type of patch cord, quantity, length, and color provided as part of the Final Acceptance.
   1. Copper Patch Cords

      a. Category 6 Patch Cords
         1) Patch cords shall be constructed from Category 6 4-pair 24 AWG, stranded patch cable material.
         2) Patch cord cable assembly shall be UL→ listed and meet FCC Part 65 plug and termination.

Item	Manufacturer	Part Number	Qty.	Length	Color	Description
1	Leviton	6D460-3L		3’-0”	Blue	Data
2	Leviton	6D460-5L		5’-0”	Blue	Data
3	Leviton	6D460-7L		7’-0”	Blue	Data
4	Leviton	6D460-10L		10’-0”	Blue	Data
5	Leviton	6D460-07W		7’-0”	White	Workstation
6	Leviton	6D460-10W		10’-0”	White	Workstation
7	Leviton	6D460-3E		3’-0”	Black	Data
8	Leviton	6D460-5E		5’-0”	Black	Data
9	Leviton	6D460-7E		7’-0”	Black	Data
10	Leviton	6D460-10E		10’-0”	Black	Data
11	Leviton	6D460-3Y		3’-0”	Yellow	Data
12	Leviton	6D460-5Y		5’-0”	Yellow	Data
13	Leviton	6D460-7Y		7’-0”	Yellow	Data
14	Leviton	6D460-10Y		10’-0”	Yellow	Data
15	Leviton	6D460-3R		3’-0”	Red	Wireless
16	Leviton	6D460-5R		5’-0”	Red	Wireless

Item	Manufacturer	Part Number	Qty.	Length	Color	Description
17	Leviton	6D460-7R		7'-0"	Red	Wireless
18	Leviton	6D460-10R		10'-0"	Red	Wireless

2. Optical Fiber Patch Cords
   a. Multimode Patch Cords (OM3)
      1) Optical fiber patch cords shall be 50/125 μm with metal ferrules, constructed from OFNR rated dual fiber cordage, in the color aqua.

Item	Manufacturer	Part Number	Qty.	Length	Color	Description
1	Leviton	5LDSC-M01		1M	Aqua	SC – SC
2	Leviton	5LDSC-M02		2M	Aqua	SC – SC
3	Leviton	5LDSC-M03		3M	Aqua	SC – SC
4	Leviton	5LDLC-M01		1M	Aqua	LC – LC
5	Leviton	5LDLC-M02		2M	Aqua	LC – LC
6	Leviton	5LDLC-M03		3M	Aqua	LC – LC
7	Leviton	5LDCL-M01		1M	Aqua	LC – SC
8	Leviton	5LDCL-M02		2M	Aqua	LC – SC
9	Leviton	5LDCL-M03		3M	Aqua	LC – SC

PART 3 EXECUTION

3.01 ADDITIONAL CABLING

A. Provide an additional 12 Category 6 cables to be located during construction by the Owner. Workstation devices shall be as specified herein including but not limited to; cabling, faceplates, modules, blank modules, open cabling supports, labeling and testing.
   1. Assume an installed cable length of 295'.

3.02 GENERAL

A. Include labor, materials, tools, equipment and services for installation as indicated on the Contract Documents.

B. Coordinate Work with other trades for complete and operational system.

C. Include supplementary and miscellaneous items, appurtenances, and devices incidental to and necessary for sound, secure, and complete installation, whether or not specifically indicated in the Contract Documents.

D. Provide suitable barriers and take any other safety precautions required by applicable codes.

E. Work area shall be kept free from debris of all types and remove all rubbish resulting from their work on the premises. Upon completion, vacuum and clean room floors, equipment racks, enclosures and cable management where work has been performed.

F. Contractor shall be responsible for any building repairs made necessary by their work or caused by negligence of their employees. No cutting, notching, drilling or altering of any kind shall be done to the building without first obtaining permission from the Owner.

G. Owner may have other contracts in connection with this work for the installation of software and equipment. Contractor shall provide other Trade Contractors reasonable opportunity for the introduction and execution of their work and shall properly coordinate other trade's work with theirs as required.

H. Provide patch panels and blocks indicated on the telecommunications drawings whether or not they are fully populated with cables.

I. Provide cables, devices and equipment racking systems as indicated on the Contract Drawings.

3.03 ABANDONED CABLING

A. Contractor shall be responsible for the demolition, removal and disposal of all existing abandoned telecommunications cabling and infrastructure in its entirety per NEC Article 800 and as identified on the Contract Drawings. Abandoned cabling shall be defined as any telecommunications cabling that is not terminated at both ends at a module or other equipment and is not identified for future use with a tag.

B. Telecommunications cabling and infrastructure shall include but not limited to, faceplates, surface mount boxes, RJ11 and 8P8C modules, horizontal UTP cabling, copper and optical fiber backbone infrastructure, innerduct, cabling support systems, equipment racks, horizontal and vertical cable management, equipment shelving, ladder tray, dedicated telecommunications surface raceway, 110 and 66 blocks, rack mount and surface mount fiber cabinets and other related passive infrastructure.

C. Provide blank cover plates for demolished flush mount outlets, surface mount boxes; modular furniture feed locations, and junction boxes.

D. Provide blank cover plate for demolished modular furniture telecommunications devices. Match modular furniture manufacturer system, make and base channel color.

E. Provide new cover plates for surface mount raceway systems after demolition of existing devices. Cover plate sections shall be seamless between new devices. Cover plates shall match existing base color.

F. Provide fire stopping of existing horizontal and vertical conduit sleeve, after existing horizontal and backbone cabling has been demolished. Provide fire stopping of existing wall penetrations. Seal all penetrations with approved fire stopping materials.

G. Provide (2) pull strings in each vertical conduit riser sleeves at the completion of demolition of existing cabling.

3.04 OPEN CABLING SUPPORT INSTALLATION

A. Cabling shall be run exposed as "open cabling" in ceiling spaces and ceiling plenums, unless otherwise noted.

B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.

C. Cabling supports shall be spaced no further than 4'-0" apart.

D. Cabling bundles shall not sag a maximum of two inches from the bottom of the cable support.

E. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.

F. Floor penetrations shall be at columns, exterior walls unless otherwise specified.

G. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.

H. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.

I. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.

J. Follow manufacturer's recommendations for quantity of cables supported in J-hooks and adjustable cable supports.

K. Installers shall observe the applicable requirements and recommended good practices contained within TIA-568-C standard for cabling installation requirements.

3.05 CABLING INSTALLATION

A. Telecommunications devices shall be connected to the horizontal cross-connect in a telecommunications room with horizontal cabling installed in star topology.

B. Horizontal cabling shall be installed in continuous runs from the telecommunications rooms to telecommunications device locations. Splices are not permitted.

C. Maximum length of horizontal cables shall be 295 feet (90 m) including all service loops.

D. Cabling shall be installed in accordance with manufacturer's recommendations, including but not limited to maximum tensile loading and maximum bend radius.

E. Cabling shall be organized and identified so as to facilitate locating and handling individual sheaths for maintenance functions.

F. Bundles shall be neatly secured without cinching or stressing the cabling, using hook and loop fasteners in open cabling installations and in the telecommunications room. Hook and loop fasteners shall be loose enough so that the fastener can be easily rotated around the cabling bundle and does not impact the physical construction of the cabling.

G. Provide machine typed label on both ends of the horizontal cabling jacket no more than 4-inches from each termination point.

H. Great care shall be taken to protect all cabling from physical damage beneath floors, above ceilings or elsewhere. Cabling shall not be exposed to any forces or handling factors that will degrade performance, such as crushing, pull stressing, twisting, or damaging sheathing materials. When left unattended, all cabling shall be secured and protected to avoid damage.

I. Hook and loops fasteners shall be utilized in the telecommunications room for all cabling bundles. Tie wraps are prohibited in the telecommunications rooms and spaces.

J. A spare pull string shall be installed at every outlet installed.

K. Horizontal and backbone cabling shall be bundled and routed separately in dedicated cabling supports in a neat and organized fashion for routing from the telecommunications rooms utilizing cable trays and open cabling pathways to the telecommunications devices.

L. Route cabling runs from workstations parallel to building grid lines and directly to open cabling pathways without passing over adjacent office spaces or cubicles.

M. Provide 5 feet of slack in neatly suspended loops above each workstation and 10 feet of slack neatly coiled in the ladder rack or cable tray in the telecommunications room unless indicated otherwise on Contract Drawings. Service loops in the telecommunications room shall not be located above the equipment racks and server enclosures.

N. Cables shall contact only dedicated and properly protected cable accesses and support mechanisms.

O. Telecommunications unshielded twisted pair cabling supported utilizing open cabling methods shall maintain a minimum separation of three inches from fire alarm, intercom/paging, clocks and security cabling. Cabling supports shall maintain increased separation requirements when attaching to the same hanger rod to ensure cabling sag maintains the minimum three inch separation.

P. Maintain the following distances between cabling and other building systems:
   1. One foot from fluorescent lights.
   2. Six feet from motors and transformers.
   3. Three feet from water piping or other mechanical equipment.
   4. One foot from electrical conduits or other electrical equipment.

3.06 CONNECTIVITY AND CABLING INSTALLATION

A. Cabling shall be dressed and terminated in accordance with the cabling installation requirements identified in TIA-568-C, BICSI Telecommunication Cabling Installation Manual, and the manufacturer's documentation.

B. Cabling entering the telecommunications room and routing on the ladder rack or cable tray pathway shall be separated into cabling bundles specific to the patch panel in which it will be terminated to. Cable bundles shall be in increments of 24 cables.

C. Cabling shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the equipment rack, enclosure or backboard.

D. Cabling transitioning from ladder rack or cable tray pathway shall maintain proper bend radius utilizing waterfall device brackets for transitioning vertically down the side rail of an equipment rack or server enclosure as to not impact the physical jacket construction of the cable. Waterfall device brackets shall also be utilized for transitioning cabling to blocks mounted on plywood. Cabling that become damaged during this transition shall be replaced in their entirety.

E. Cables shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support straps. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

F. Installation of 8-position 8-conductor modular jacks into faceplates and attaching of the faceplates to the wall shall ensure that the faceplates are flush. The faceplate shall be secured to the wall but shall not be secured to the wall with such force as to bow the faceplate.

3.07 WORK AREA

A. 4-pair UTP horizontal cabling shall be terminated on an 8-position 8-conductor modular jack or plug at each telecommunications device as indicated on the applicable Contract Drawings.

B. Telecommunications devices shall be provided with 8-position 8-conductor modular jacks or plugs in the quantity as indicated on the applicable Contract Drawings.

3.08 CABLING TERMINATIONS

A. Provide all necessary installation materials, tools and equipment to perform insulation displacement type terminations at all the telecommunications outlets, patch panels and 110 cross-connect blocks.

B. Pairs in each cable shall be terminated on a 110 block, modular patch panel or telecommunications modules in accordance with this specification.

C. Cabling shall be terminated in accordance with the T568B pin configuration standard.

D. Remove only as much of the cable sheath as is necessary to terminate the cabling on the connecting hardware.

E. A maximum of 0.25” of cable pair twists shall be removed from a 4-pair UTP cable. Cabling and terminations exceed these dimensions shall be re-terminated.

F. At the horizontal station patch panel, the cabling shall terminate from the center of the 110 IDC termination.

G. Terminate cabling in accordance with connecting hardware manufacturer’s recommendations. All cabling shall terminate in numerical sequence.

3.09 FIRESTOPPING

A. Firestop systems shall be installed in accordance with the NEC and the manufacturer’s recommendations and shall be accomplished in a manner acceptable to the local fire and building authorities having jurisdiction over this work.

B. Cabling running through rated floors and walls shall be firestopped in accordance with the requirements within this Section.

C. Penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).

D. Penetrations created by or for the contractor and left unused shall also be sealed as part of the contractor’s scope of work.

E. Firestop putty or pillows shall be used inside conduits to provide a re-enterable system allowing telecommunications cables to be easily removed or added in the future. Firestop putty shall not be water soluble.

F. Firestop systems shall be UL Classified to ASTM E814 (UL 1479).

G. Firestopping sleeved devices shall be installed according to the manufacturer’s recommendations including, but not limited to:

1. Wiring devices shall be installed in locations where indicated on the Contract Drawings, arranged in a single or multiple sleeve formation at the height specified. Sleeves shall be installed a minimum of 6 inches above the accessible ceiling grid.
2. Install the devices in strict accordance with the approved shop drawings and the manufacturer’s recommendations.
3. Apply the factory supplied gasket material prior to the installation of the wall plates.
4. Secure wall plates to devices per the equipment manufacturer’s recommendations.

3.10 INSTALLATION OF OPTICAL FIBER CABLING SYSTEM

A. Installation for Optical Fiber Cabling:

1. Follow cable manufacturer’s specifications regarding handling methods, bend radius and maximum pulling tension limitations.

B. Securing Fiber Cabling:

1. Immediately after cabling installation, a permanent identification tag as indicated shall be attached to visible cabling sections. Cabling shall be checked to ensure that the markings are intact.
2. Cabling and equipment shall be supported and secured as indicated. Where the specific method of support is not indicated, supports and fasteners shall be used to secure cabling and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish. All cabling shall be routed along the interior sides of manholes.

3. Corrosion resistant clamps and straps shall be used as necessary to properly secure the cabling.
4. Optical fiber cabling shall be secured to the optical fiber cabinet using the aramid strength yarn of the cabling to provide strain relief.

C. Optical Fiber Cabling Bending:
1. Caution shall be used when bending cabling to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of 20 times the cabling diameter. Minimum radius shall be increased when necessary to meet cable manufacturer's recommendation. Cabling shall not rest against any sharp edges.

D. Optical Fiber Cabling Pulling:
1. Pulling lines shall be attached to both cable ends when cabling is destined for bi-directional pull, and fitted with factory-installed pulling eyes where possible. Cabling not equipped with a pulling eye shall have the pulling line attached to the cable end by means of a cable grip. Core hitches shall not be used.
2. Cable reels shall be located and aligned so that the cable is payed out from the top of the reel by rotating the reel in the feed direction at the rate of pull into the duct or conduit in a long, smooth bend without twisting. Cabling shall not be payed out from the bottom of the reel or by pulling. A cable feeder guide of proper dimensions shall be used at the mouth to guide the cable into the duct or conduit.
3. Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Cable ends shall not be pulled around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.
4. Equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cabling shall be payed out without stopping until the required amount of the cabling has been placed. If the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cabling shall be overcome by increasing the tension in small steps a few seconds apart until the cabling is in motion.
5. Pulling tension shall not exceed 500 lbs. or cable manufacturer's recommendation, whichever is less.
6. Provide a 20’ foot service loop for all optical fiber cabling located at both ends of the cabling run in all telecommunications rooms and in utility vaults. Service loop shall be attached to the fire retardant plywood backboard and shall not be located on the ladder rack or cable tray.
7. Do not pull optical fiber cables with copper cables.
8. Do not pull optical fiber cables over existing cables.
9. When pulling optical fiber cabling in an innerduct or conduit, do not exceed the 40% fill ratio.

E. Optical Fiber Cabling Terminations:
1. Cable terminations shall be made in optical fiber distribution units. All installed optical fiber strands shall be terminated.

2. Optical fiber cabling terminations shall utilize enclosures and components in quantities consistent with the required fiber counts at each end of each segment. During optical fiber connector termination and polishing, visually inspect all terminations with a 400-power microscope. Follow all of the connector manufacturer's recommendations. Unacceptable flaws in the terminations will include, but not limited to, scratches, full or partial cracks, bubbles, pits, epoxy residual, dirt, dust, oil, moisture, grinding and sanding debris. The acceptable final polish will show a connector tip that is free of all imperfections in 100% of the core and 80% of the cladding. All unacceptable connectors shall be inspected after rework.
3. Optical fiber cabling slack shall be neatly coiled within the optical fiber cabinet. No slack loops shall be allowed external to the optical fiber cabinet.
4. Cables shall be clearly labeled at the entrance to the fiber adapter panel.
5. To maintain the correct polarity throughout the optical fiber cabling system, each cabling segment shall be installed in a pair-wise crossover orientation as defined in TIA 568-C.
6. Dust caps shall be installed on the connectors and couplings.

3.11 LABELING

A. General:
   1. Labeling shall be in accordance with TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure.
   2. Labels shall be permanent typewritten labels produced by a labeling machine.
   3. Labels shall be installed on all cabling at each end. Ensure labels are securely fastened.
   4. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
   5. Font type for each type of label shall be Arial with maximum size font allowed.
   6. Labeling information will be reviewed at the Pre-Construction Meeting.
   7. Labeling shall be completed prior to the Substantial Completion date of the project.

B. Telecommunications Device Labeling:
   1. Label shall be produced to fit into the recess provided and covered with a clear plastic cover.
      a. ##-TR1A-2-03-04 where:
         1) ## = Building number
         2) TR = Telecommunications Room (MC, IC, HC or as indicated on the Contract Drawings)
            a) TR(1) = Floor Number
            b) TR1(A) = Telecommunications room where multiple TRs exist on a floor. Letter designation shall occur from West to East for the locations of the TR.
         3) –2 = Equipment rack number
         4) –03 = Patch panel number
         5) –04 = Port number
   2. Above Ceiling Device Labeling
      a. A label on the ceiling grid shall be provided at each location where a network device is located above the ceiling. The label shall be machine generated. The text shall be in bold white letters on black background printed on 3/4" tape with the maximum font size allowable.

b. Labeling shall be as follows:
   1) '*WAP*' - TR-2-03-04 where:
      a) WAP= Device type as indicated on the Contract Drawings
      b) TR-2-03-04=Cable ID Label

C. Equipment Rack Labeling:
   1. Plastic lamacoid nameplate shall be provided for each equipment rack and/or server enclosure in the telecommunications room.
   2. Plastic lamacoid nameplate shall be black with white letters. The nameplate shall be machine engraved with a size 36 font.
   3. Mount the name plate at the top of each equipment rack, server enclosure or wall mount enclosure.
   4. Labeling scheme shall be as indicated on the Contract Drawings.

D. Patch Panel Labeling:
   1. Station Patch Panel
      a. 48-port modular patch panels shall be labeled with sequential numbering starting with "01" for the topmost patch panel and moving downward to the bottom of the rack. Patch panel labels shall be affixed to the left hand side of the patch panel.
      b. Horizontal cabling distributed from station patch panels to specialty devices (i.e. wireless access points, security devices and IP intercom speaker digital clocks) shall have a label in the designation strip space directly below the 8P8C module identifying the device interconnect point, the designation label shall be as follows:
         1) "WAP - #", where the "#" represents the Owner's wireless access point identification number.
         2) "CAM - #", where the "#" represents the Owner's security video camera identification number.
         3) "AC - #", where the "#" represents the Owner's IP Access Control room/space identification number.

E. Rack Mount Fiber Cabinet Labeling:
   1. RMFC shall be labeled with sequential numbering starting with "FC1" for the topmost fiber cabinet and moving downward to the bottom of the rack. Labels shall be affixed to the left hand side of the RMFC.

F. Optical Fiber Termination Labeling
   1. Labeling shall be placed within the designation strip holder of the fiber connector panel where designation strips are provided with the connector panel.
   2. Labeling shall be placed on the inside of the front door for surface mount fiber cabinets and rack mount fiber cabinets where no designation label strips are provided. The label shall be in the same orientation of the connector panel.
   3. Labeling shall contain the originating telecommunications room designation, rack row if applicable, equipment rack number designation, rack mount fiber cabinet number, fiber adapter panel position(s) and the associated fiber strand numbers by individual strands and/or optical fiber subunit classification.
   4. Main Cross-connect will have labeling associated for the distribution of optical fiber cabling to each telecommunications room and the telecommunications room (IC or HC) will have labeling associated from the Main Cross-connect.
   5. Backbone Optical Fiber Labeling:
      a. Labeling shall be as follows in the originating telecommunications room:
         1) HC1.A:1-6 where:
            a) HC1 = telecommunications room

b) .A = Connector panel position
c) :1-6 = Strand numbers per connector panel

b. Labeling shall be as follows in the originating telecommunications room:
1) MC.A:1-6 where:
a) MC = Telecommunications room
b) .A = Connector panel position
c) :1-6 = Strand numbers per connector panel

6. Horizontal Optical Fiber Labeling:
a. Labeling shall be as follows at both ends:
1) MC.A:1-2 CAM.# where:
a) MC = Telecommunications room
b) .A = Connector panel position
c) :1-2 = Strand numbers per device
d) CAM.# = Device name and number

G. Cable Identification Tag Labeling:
1. Optical fiber and copper backbone cabling shall be clearly and visibly identified by the contractor in all manholes, pull boxes, riser room pull points, entrance points, service entrance and 3' before entering a free standing rack, wall mounted enclosure or surface mount fiber cabinet utilizing an optical fiber cable identification tag.
2. Optical fiber and copper backbone cable identification tags shall contain the following information at a minimum.
a. Cable manufacturer and part number
b. Extent of cable run (i.e. “From: MC – To: HC1A”)
c. Cable type and description (i.e. “In/Outdoor Loose Tube, OM3 12-strand”)

3.12 TESTING

A. Test procedures shall be as prescribed by the TIA, Insulated Cable Engineers Association and the National Electrical Testing Association.

B. Test Equipment:
1. Network testing equipment shall be a Fluke Networks DSX-5000 Cable Analyzer or equal and shall have a certified calibration from the manufacturer within the past 12 months at the time of testing. Proof of calibration shall be provided with the product submittal. Test equipment shall be utilized to test horizontal and backbone cabling.
2. Field tester and adapters shall be certified by an independent laboratory as meeting or exceeding current level as defined in TIA-1152 Level IIIe.
3. 8P8C test plug for the network testing equipment adapters shall be in range of values defined in Annex C with TIA-568-C for Near-end Crosstalk, Far-end Crosstalk and Return Loss.
4. Test equipment shall support the complete suite of Resistance Unbalanced standards for PoE per IEEE 802.3af, IEEE 802.3at and TIA-568-C.2.
5. Test equipment shall be able to test up to a 1000 MHz frequency range.
6. Test equipment shall be ISO 9001 certified.
7. An electronic copy of the manufacturer’s testing procedures shall be kept in the job site office.
8. Test equipment batteries shall be charged daily and a level of greater than twenty-five percent of capacity shall be maintained during the testing.
9. Test equipment shall be calibrated daily before the start of testing.

C. Horizontal Cabling:
   1. Horizontal cabling shall be certified to meet or exceed the permanent link performance specifications for Category 6 horizontal cabling tested with a frequency range from 1MHz to 250 MHZ as defined in TIA-568-C.
   2. Certifications shall include the following parameters for each pair of each cable installed:
      a. Building identification
      b. Cable identification
      c. Date of test
      d. Test equipment manufacturer and model number
      e. Wire map
         1) Continuity to the remote end.
         2) Shorts between any two or more conductors
         3) Reversed pairs
         4) Split pairs
         5) Transposed pairs
         6) Any other miswiring
      f. Length
      g. Near-end crosstalk (NEXT)
      h. Attenuation to crosstalk ration far-end (ACRF)
      i. Power sum Attenuation to crosstalk ration far-end (PSACRF)
      j. Power sum-near-end crosstalk (PS-NEXT)
      k. Return loss (RL)
      l. Propagation delay (PD)
      m. Delay skew (DS)
   3. Horizontal cabling shall be tested using a Permanent Link configuration as defined in TIA-568-C.
   4. Test reports with an asterisk (*) or fails, shall be documented identifying the reason for the test failure and a corrective action plan developed.
   5. After corrective action has been completed, the permanent link shall be retested.
   6. It is the Telecommunications Contractor’s responsibility to ensure 100 percent of the network horizontal cabling system links pass all tests.
   7. Test results shall be organized by building identification and cable identification number. The test results shall contain the date and time of when each test was saved in the memory of the tester. The test results shall be recorded on a flash drive in both PDF and LinkWare software formats.

D. Backbone 100 ohm UTP Cabling:
   1. Continuity tests shall be performed on all backbone cabling pairs and/or conductors.
   2. Testing procedures shall include the following parameters for each pair of each cable installed:
      a. Wire map
         1) Continuity to the remote end.
         2) Shorts between any two or more conductors
         3) Reversed pairs
         4) Split pairs
         5) Transposed pairs
         6) Any other miswiring

b. Length

3. Tests shall be recorded as pass/fail as indicated by the test set in accordance with the manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number.
4. Cabling links that fail the testing will be documented, identifying the reason for test failure and a corrective action plan.
5. After corrective action has been completed, the link shall be retested.

E. Optical Fiber:

1. Acceptance Testing
   a. Optical fiber test jumper shall be properly cleaned at both ends prior to the start of testing for each backbone segment.
   b. A reference power measurement shall be obtained by connecting one end of test jumper 1 to the light source and the other end to the power meter tester. After recording the reference power measurement, test jumper 1 shall be disconnected from the power meter tester without disturbing the light source and attached to the cable plant. The power meter tester shall be moved to the far end of the cable plant and attached to the cable plant with test jumper 2.
   c. Multimode optical fiber attenuation shall be tested and recorded at a minimum of three times on all individual fiber strands of each cable using the power meter tester configuration to determine the actual loss and the connector repeatability. Each of the three tests shall be recorded and a final value with the average of the three tests shall also be recorded. The connector repeatability shall not exceed 0.2 dB as defined by Telcordia GR-326-CORE. These tests shall be performed at the 850nm and 1300nm windows in bi-directional testing. Test set up and performance shall be in accordance with TIA/EIA-526-14A, Method B, and TIA-568C.0.
   d. After terminating optical fiber cabling, one of the individual fibers of each cable segment shall be tested using an OTDR to determine the actual length. One strand of each optical fiber buffer tube shall be tested with an OTDR.

3.13 PATCH CORD INSTALLATION SUPPORT

A. Provide installation of the copper and optical fiber patch cords between the active network electronics, horizontal station patch panels and voice cross-connect patch panels.
   1. Coordinate with the owner for patching and switch requirements.
   2. Contractor shall request the port identification patching matrix from the Owner in writing a minimum of three weeks in advance of starting the patch cord installation.

B. Patch cords shall be routed in a neat and orderly fashion, maintaining proper bend radius of the patch cords as to not decrease the system performance. Utilize horizontal and vertical cable management, including all bend radius support attachments to their fullest extent.

C. Horizontal cable management panels that contain small retainer clips at the top and bottom of the panels, a maximum of three patch cords shall be held within the retainer clips when interconnecting into patch panels or network switch ports.

D. Patch cords with sufficient length shall be utilized as to not damage or stretch the cable jacket but the lengths shall not be more than 18 inches in excess length stored within the vertical cable management.

E. Patch cords shall be routed horizontally in the cable management panels and transition upward and downward within the vertical cable management sections. Patch cords shall not be dressed top to bottom on the fronts of the equipment racks.

F. For bidding and installation purposes, assume a total of 36 copper patch cords and 3 optical fiber patch cords to be installed within the project site.

G. At the completion of the patch cord installation, provide an updated port identification patching matrix, in Microsoft Excel format, indicating the network switch number, switch blade number and switch port number that the patch cords interconnect occurred from the horizontal station patch panel. Provide a column indicating specific function uses of the switch port. Coordinate the specific function identifications and classifications with the Owner and Owner's Representative prior to the start of the installation.

END OF SECTION

Use the following table to track the installation of the additional workstation cabling as described in Paragraph 3.1.A.

Port Qty.	Room Name	Room No.	Date of Install

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: The following sections apply to Work in this Division:

1. Section 260500 General Electrical Provisions
2. Section 260510 Basic Electrical Materials and Methods
3. Section 260511 Electrical Connections for Equipment
4. Section 260512 Electrical Demolition
5. Section 260519 Wire and Cables
6. Section 260529 Supporting Devices
7. Section 260533 Raceway Systems
8. Section 260548 Vibration Isolation and Seismic Control for Electrical Systems
9. Section 260553 Electrical Identification
10. Section 260534 Outlet Boxes

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. This section is a Division 28 Basic Electrical Materials and Methods section and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplemental Conditions, Division 01 Specification sections and all Division 28 sections, apply to work of this section.

PART 2 GENERAL PROVISIONS

2.01 CONTRACT DRAWINGS

A. The contract drawings indicate the extent, the general character, and the approximate location and arrangement of equipment, conduit, ground connections and wiring. Contractor shall study building plans and details and shall cooperate with all other trades to prevent conflict and interference as to space requirements so that outlets and equipment will be properly located and readily accessible. The layout does not necessarily show the total number of raceways or boxes required, nor are the location of indicated runs intended to show the actual routing of the raceways. The Contractor shall provide all raceways, boxes, conductors, connections, supports, and all other materials required for the electrical systems shown or noted in the contract documents to be complete and fully operational upon completion of the project.

B. Division 28 equipment shall be properly supported to comply with applicable codes and good work practice. Be responsible for installation of a complete electrical installation in accordance with the true intent of the drawings and specifications.

C. The scale of drawings cannot show all necessary transitions, offsets, changes in direction, etc. The drawings do not necessarily show every pull or junction box required. Provide all boxes necessary to install work to conform to the structure, preserve head room and keep openings and passageways clear.

D. Diagrams, details, risers and One-Line Diagrams are schematic only, not to scale, and do not necessarily show physical arrangement of equipment. Diagrams and plans are complementary and what is shown on either is same as if shown on both.

E. The specifications and drawings are complementary and what is required in either is as binding as if indicated on both. Where a conflict exists between what is shown on the drawings and what is called for in the specifications, the more stringent of the two shall govern.

F. The Contractor will not receive extra compensation for cutting, patching, wiring and finishing required for relocation of work installed due to interference between the various work that could have been avoided, had proper coordination been applied. The Contractor is advised to contact the Architect or Engineer to clarify any situation that does not appear to conform with standard practice.

G. The Contractor shall make provisions for the delivery and safe storage of materials and make arrangements with the other work of other Divisions for entry into buildings of equipment too large to pass through finished openings. Be responsible for materials and equipment furnished to him by others for installation into the project. Material damaged during construction shall be replaced or repaired to the Owner's satisfaction.

2.02 REFERENCE SYMBOLS & DEFINITIONS

A. ADA Americans With Disabilities Act

B. Ampacity Capacity expressed in amperes

C. ASTM American Society for Testing & Materials

D.	EMT	Electrical Metallic Tubing
E.	Galv.	Galvanized
F.	Mfg.	Manufacturer
G.	NEC	National Electrical Code
H.	NBFU	National Board of Fire Underwriters Pub. 70 (latest edition)
I.	UBC	Uniform Building Code
J.	Furnish	Supply
K.	Install	Or apply
L.	Provide	Furnish and install
M.	UL	Underwriters Laboratories, Inc.
N.	IPCEA	Insulated Power Cable Engineers Association
O.	NEMA	National Electrical Manufacturers Association
P.	IEEE	Institute of Electrical & Electronic Engineers
Q.	NFPA	National Fire Protection Association
R.	Indicated	Indicated on drawings
S.	Concealed	Hidden from sight as in trench, chases, slabs, furred spaces or hung ceilings
T.	Exposed	'Not concealed' as defined above
U.	Contractor	Shall mean the General Contractor who signs the contract with the Owner

2.03 CODES & FEES

A. The installation of this work shall comply in every way with the requirements of the laws, ordinances and rules of the State of Washington, the National Electrical Code, and WISHA.

B. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming with governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

PART 3 EXECUTION

3.01 WORK INCLUDED

A. It is the intention of this Division of the specifications and the accompanying drawings to describe and provide for furnishing installing, testing and placing in satisfactory and successful operation, all equipment, materials, devices and necessary appurtenances to provide a complete security control system. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation including support and accessibility of all security and electrical systems shown on the plans or described herein. Certain equipment and devices furnished and installed under other contracts shall be connected under this contract.

B. All work and materials shall be subject to inspections at any and all times by representatives of the Owner and/or Architect.

C. The Contractor shall circuit all devices and equipment to the rack as indicated or specified. Any deviation from the drawings shall be approved by the Engineer, documented by the Contractor and approved by the Labor and Industries Inspector.

3.02 CUTTING, PATCHING, EXCAVATION AND BACKFILL

A. Workmanship shall be of the best quality and none but competent mechanics shall be employed and shall be under the supervision of a competent foreman. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.

B. No cutting of structural members will be allowed without the Architect's written permission.

C. All patching provided by the Contractor shall be done by mechanics skilled in their trade and shall be complete in every detail and shall comply with Division 01 and appropriate sections of the specification for material, finish, etc. All patching shall be reviewed by the Architect for acceptability.

3.03 CLEANUP

A. Continually remove debris, cuttings, crates, cartons, etc. created by his work from the inside to the secure perimeter on a daily basis. Such shall be done at sufficient frequency to eliminate hazard to the public, other workmen, the building or the Owner's employees. Before acceptance of the installation by the Owner, carefully clean cabinets, panels, boxes, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

3.04 PAINTING

A. Touch up or repair of factory finishes that are scratched or marred in shipment or installation shall be the responsibility of this Division. Repairs shall be made to the satisfaction of the Owner and/or Architect.

3.05 EXAMINATION OF SITE

A. Before submitting bids, all bidders on Division 28 work shall visit the site to satisfy themselves as to the nature and scope of all work to be done. The submission of a bid will be taken as evidence that such an examination has been made and difficulties, if any, noted. Later claims for labor, work, materials and equipment required for any difficulties encountered which could have been foreseen, will not be recognized and all such difficulties shall be properly taken care of at no additional expense to the Owner.

3.06 SAFETY CONDITIONS

A. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Architect to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's performance measures, in, on, or near the construction site.

B. Furnish, erect and maintain all barricades, guard structures, warning signs, detour signs and lights as may be required to protect and safeguard from injury or damage.

C. Provide bracing, scaffolding, guard rails and protective devices necessary to protect workmen and personnel from personal injury while on the jobsite.

D. Contractor shall be liable for all damage and injury occurring to the Owner's property on or in the adjacent areas of the work, or which shall occur to any person or property whatsoever by reason of the negligence of the Contractor or any of his employees, or sub- Contractors, or of any breach or violation of the provisions of this agreement, or of any of his duties or obligations under the contract.

3.07 PROJECT CLOSEOUT

A. At the time of monthly and final inspections, the project foreman shall accompany the inspection party, and remove plates, covers, ceiling tiles and other access panels and unlock doors for the inspecting Engineer, to allow complete inspection of the entire security system in an efficient manner.

B. The Contractor shall provide all ladders and tools required by the inspecting Engineer. The Contractor shall open any panel, box, control station, racks, etc. as requested for the Architect/Engineer’s inspection.

C. Guarantee: This Contractor shall be responsible for all work put in under this specification. Make good, repair or replace, as may be necessary, any defective work, materials or parts which may show itself within one year after date of owner occupancy and one year for labor, if in the opinion of the Architect, said defect is due to imperfection in materials, design or workmanship. Comply also with requirements of other divisions of specifications.

D. The Contractor shall leave the job in complete order ready for use. All refuse shall be removed, all fixtures, devices and equipment shall be tight, fully equipped and completely cleaned. Operation personnel shall be thoroughly indoctrinated in the operation of electrical and systems equipment. All remaining items not used in the project, but billed for shall be delivered in like new condition to the Owner's on-site storage facility.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Provide an electronic access control system and other relevant components and accessories required to provide a complete operating system as specified herein.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 sections and Section 260500 apply to Work in this section.

1.02 RELATED SECTIONS

A. Related Sections
   1. 260500 – General Electrical Provisions
   2. 260510 – Basic Electrical Materials and Methods
   3. 260533 – Raceway Systems
   4. 260534 – Outlet Boxes
   5. 271100 – Telecommunications System
   6. 281600 – Intrusion Detection System
   7. 282300– IP Security Video System

1.03 QUALITY ASSURANCE

A. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for security access control applications.

B. Codes and Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI C63.4 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
   2. Federal Communications Commission (FCC):
      a. Title 47 CFR – Part 15; Class B – Radiated and Conducted Emissions.
      b. Title 47 CFR – Part 68; rules governing the connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN).
   3. Underwriters Laboratories, Inc. (UL):
      a. UL 50 – Enclosures for Electrical Equipment.
      b. UL 294 – Access Control System Units.
      c. UL 60950-1 – Information Technology Equipment - Safety.
   4. National Fire Protection Agency (NFPA):
      a. NFPA 101 Life Safety Code.
   5. Provide all wiring in accordance with Article 725 of the National Electrical Code and local ordinances, and other sections of these specifications.

C. Qualifications:
   1. Contractor shall be a certified reseller/ dealer, pre-qualified by the manufacturer for the purpose of offering the services as specified herein, at the time of bid.
   2. Contractors bidding security work shall have a minimum of five years of experience in the construction, testing, and servicing of systems of the type and magnitude specified herein.
   3. The contractor shall have completed at least five projects of equal or larger in size to this project within the past five years.

4. Contractor shall have direct access to the tools and test equipment required to complete the work as defined herein.
5. The contractor shall employ certified technicians skilled in the maintenance of the access control system and shall be located within 100 miles of the project site.

1.04 SUBMITTALS

A. Provide submittals in accordance with Division 01 and Section 260500.

B. Product Data:
   1. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.
   2. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
   3. Submit Product Data information sheets for coordination with item and model number.
   4. Where more than one product is shown on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
   5. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:
      a. Manufacturer’s certification to provide warranty
      b. Approved manufacturer classes satisfactorily completed

C. Acceptance Test Plan:
   1. An acceptance test plan form shall be prepared/ provided by the contractor.
   2. This form shall include separate sections for each device and a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

D. Shop Drawings:
   1. Drawings shall provide details of proposed system and the equipment and work to be provided. Drawings shall include devices located on the floor plan, point-to-point drawings of systems and wiring diagrams of individual devices including voltage drop calculations and other calculations as required.
   2. Connections to other equipment/ systems not specified herein.

E. Record Drawings:
   1. Keep complete set of security drawings in job-site office to show actual installation of cabling and equipment during construction.
   2. Use of this set of drawings for recording as-built conditions.
   3. Indicate where material, equipment, and system component are installed differently from that shown on the Drawings.
   4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner’s Representative for review and acceptance.
   5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
      a. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
   6. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.

F. Project Closeout:
   1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
   2. Provide all project closeout documentation including but not limited to; test acceptance documentation, Record Drawings, manufacturer warranty and Operation and Maintenance Manuals.

1.05 SYSTEM REQUIREMENTS

A. Type of System:
   1. The system shall be programmable locally and/or remotely.
   2. Wireless access control door hardware shall communicate over a secure 2.4 GHz frequency. Wireless door hardware is furnished under Division 08.
      a. Licensing, configuration and installation shall be provided under this specification.
   3. Access control system shall provide the following card access control operational objectives:
      a. Controlled entry, via access card readers, of only authorized personnel to secured areas based on cardholder information entered and stored in the system database.
      b. Access request response time from card presentation, data base verification, to electric lock unlock shall be no more than one second in normal operating mode on a fully loaded system.
      c. Access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.
      d. Each card can be disabled at any time, manually or scheduled within the system.
      e. Each cardholder shall be granted with access authority to a specific or combination of security areas.
      f. System shall provide for the designation of certain calendar days to be holidays, with special access privileges and system activity to be specified for those days.
   4. The system shall provide the following relay output control and operational functions:
      a. Each security system output point (door lock, gate controller and other associated relay outputs) shall have a user-specified 16 character, minimum, test identifier. Each point shall be software programmable for activation and deactivation, and shall be capable of reporting short circuit trouble, open circuit trouble, ground fault trouble and circuit fault trouble.
      b. System shall allow activation and deactivation of output points manually by the operator, automatically by time zone, automatically by the activation of an alarm point, or where required by a card reader.
      c. System shall allow disabling the exterior auto operator button when door hardware is in a locked state.
      d. System shall allow control (enable/disable) over the elevator call/ cab buttons.
   5. System shall provide lockdown functions via push buttons as indicated on the Contract Documents.
      a. When the lockdown button is activated it shall override all scheduled openings and lock/close all electronic controlled doors/gates.

1.06 PRE-CONSTRUCTION MEETINGS

A. The subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.

B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative.

1.07 MATERIAL PROVISIONS

A. Deliver materials to the Owner under provisions of this section.

B. Contractor shall be responsible to provide a material transmittal for all materials being provided to the Owner as described herein and that are not permanently installed. Transmittal shall be signed by the General Contractor and the Owner receiving the materials.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Substitutions: The substitution of products shall not be considered under the terms and conditions of this Section.

B. Access Control System:
   1. Best WiQ Access Control System is existing and is being expanded under this project.

C. Licenses:
   1. Licensing shall be based upon the number of readers, wireless access control door hardware, and selected features. User license shall include one year of software updates from the date of shipment from the factory.
      a. Software Support Plan:
         1) Provide one additional year of support coverage to support the system as specified herein and as indicated on the Contract Drawings.

D. System Hardware:
   1. Access control panel shall be an UL 294-Listed enclosure. Equipment shall be provided as required to support all end devices specified herein and as shown on the Contract Drawings.
      a. Provide Gateway Portals (GP) as required to support the wireless devices in the project. The drawings indicate locations. Contractor shall add Portals as required such that all devices work as intended at no extra cost. Provide Antenna as required.
         1) Model WQX-PG-XX (where XX indicate antenna)
      b. Provide Wireless Access Controllers (WAC) as indicated for all doors indicated in the documents.
         1) Model WQX-WAC-C
         2) Provide 24 VDC Power from the PLC to the WAC. Provide 2 #18 conductors as an output from the PLC to the input on the WAC for door unlock.
         3) Provide WAC in an enclosure in accessible ceiling space.
      c.

2.02 POWER SUPPLIES AND BATTERIES

A. Power Supplies:
   1. Power supplies shall be UL 294-Listed for 12V DC and 24V DC applications. Power supplies shall include 4-hour battery backup with under voltage protection. During a power interruption, power supporting security devices shall be interrupted if battery voltage drops below security device manufacturer recommendations.
      a. Manufacturer Altronix, or approved equal

B. Batteries:
   1. Batteries and associated equipment shall be provided as required to support the system as specified herein.
      a. Door hardware power supply batteries.
         1) Manufacturer, Power Sonic, 12V 7Ah, Part No. PS-1270
      b. Access control panel power supply batteries.
         1) Manufacturer, Power Sonic, 12V 5Ah, Part No. PS-1250

2.03 ACCESS CONTROL DEVICES

A. Cards and credentials shall be provided by the Owner. Provide all programming required to integrate the existing credentials.

B. Credential Readers:
   1. Signo Readers:
      a. Contactless smart card reader shall comply with the ISO 13.56MHz-related standards and bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard. Shall support 125 kHz proximity FSK (HID Proximity, AWID). PSK (Indala) and ASK (EM4102) 125 kHz technology.
      b. Contactless smart card reader shall follow the standards-based, device-independent Security Identity Object™ (SIO) portable credential methodology. The SIO shall be able to reside on any number of identity devices, including Seos, iCLASS SE, iCLASS SR, MIFARE Classic, and MIFARE DESFire EV1/EV2 credentials.
      c. Contactless smart card reader shall support, by default, Apple's Enhanced Contactless Polling (ECP) to support credentials in the Apple Wallet and Bluetooth Low Energy (BLE) and NFC card emulation mode. Reader shall be environmental rating of IP65.
         1) Manufacturer HID:
            a) Mullion reader, Part No. 20NKS-00-000000
            b) Mullion PIN pad reader, Part No. 20KNKS-00-000000
            c) Standard reader, Part No. 40NKS-00-000000
            d) Standard PIN pad reader, Part No. 40KNKS-00-000000

2.04 CONTROL BUTTONS AND RELAYS

A. Emergency Lockdown Button (Under Desk Mount):
   1. Emergency lockdown button shall be maintained, normally open DPDT contact.
      a. Manufacturers, or approved equal:
         1) Honeywell, Part No. 269R
         2) Potter, Part No. HUB-M

B. Emergency Lockdown Button (Wall Mount):
   1. Emergency lockdown button shall be red twist release mushroom style, blue shell white lettering reading "LOCKDOWN", maintained, normally open SPST contact with protective cover.
      a. Manufacturer STI, Part No. SS2421LD-EN

C. Door Release Button (Wall Mount):
   1. Door release button shall be green in color, momentary, normally open with Form "C" contacts.
   2. Custom button label shall read "PUSH TO OPEN" and faceplate label shall read "DOOR RELEASE".

a. Manufacturer STI, Part No. UB-1

D. Auto Operator Time Delay Module

1. Auto operator time delay module shall be designed to have programmable modes that include up to 3 door sequencing, airlock, lock-out relay, fire door in stairwells, and for control of automatic operators in restroom applications, with support of illuminated indicator of occupancy status.

a. Manufacturer Camden, Part No. CX-33

2.05 NOTIFICATION DEVICES

A. Sounder/ Strobe:

1. Sounder/ strobe shall be a durable indoor/outdoor self-contained device. Sounder shall consist of a single tone that delivers a warble sound output, 120dB output siren driver, and a dual action reed plunger for cover and rear protection. Strobe shall an adjustable flash rate of 20 – 10 times a minute. Housing shall be polycarbonate with a sturdy aluminum back plate to prevent warping and cracking. Sounder/ strobe shall operate at 748mA at 12VDC with a voltage range of 9.6 – 14.4 VDC.

a. Manufacturer Potter:

1) Sounder/ strobe amber lens, Part No. SSX-52SA

2) Sounder/ strobe blue lens, Part No. SSX-52SB

3) Sounder/ strobe clear lens, Part No. SSX-52SC

4) Sounder/ strobe red lens, Part No. SSX-52SR

B. Interior Chime/ Strobe

1. Chime strobe shall be a 60dB UL listed for wall installation. Chime strobe shall comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range. The strobe shall have field-selectable candela settings including 15, 30, 75, 95, 110, 135, and 185. Strobe light shall consist of a xenon flash tube and associated lens/ reflector system. Chime shall have two audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern.

a. Manufacturer System Sensor:

1) Chime strobe, Part No. CHSWL

2) Lens, amber, Part No. LENS-A2

3) Lens, blue, Part No. LENS-B2

4) Lens, green, Part No. LENS-G2

C. Exterior Strobe:

1. Exterior rated strobe shall be LED UL listed, corrosion resistant Type NEMA 4X. The base shall be in the color black with 1/2-inch or 3/4-inch NPT for conduit mounting. Lens shall be made of shatter resistant polycarbonate. Strobe shall operate Steady-On/Flashing 65 fpm at 24VDC, 0.215A.

a. Manufacturer Edwards Signaling:

1) Red lens, Part No. 125XBRMR24DB

2) Amber lens, Part No. 125XBRMA24DB

3) White lens, Part No. 125XBRMW24DB

4) Blue lens, Part No. 125XBRMB24DB

5) Green lens, Part No. 125XBRMG24DB

6) Wire guard, Part No. 125GRD

D. Emergency/ Duress Strobe:
   1. Emergency/ duress strobes shall be a xenon light source with flash rate 60 fpm. Housing shall be polycarbonate vandal-resistant IP65 with safety locking mechanism. Beacon shall be fitted with a diffuser and operate on 12VDC, 0.06A, at 1 watt.
      a. Manufacturer Edwards Signaling:
         1) Red lens, Part No. 45-713111
         2) Amber lens, Part No. 45-713121
         3) Clear lens, Part No. 45-713131
         4) Blue lens, Part No. 45-713141
         5) Green lens, Part No. 45-713151
         6) IP67 upgrade kit, Part No. 45-710002

2.06 MONITORING DEVICES

A. Request-to-exit (REX):
   1. Doors with electronic door hardware shall contain an internal micro switch REX device, coordinate with Division 08.

B. OR
   1. Request-to-exit device shall be UL 1638 and UL 464. REX shall feature timers, door monitor with sounder alert, and adjustable coverage, the REX shall have Sequential Logic Input (SLI). REX shall operate at 12VDC with 8mA nominal standby current and 39 mA in alarm. Alarm output shall be by two Form C relay contacts each rated 1 A at 30VAC/VDC for resistive loads.
      a. Manufacturer Bosch, Part No. DS160

C. Magnetic Door Position Switches:
   1.
   2. Recessed
      a. Door contacts shall be UL listed 1-inch diameter magnetic door contact DPDT (double pole/ double throw) switch. Contact shall be self-locking for recessed mounting, closed loop, with 12-inch #22 AWG leads and 1-inch gap.
      b. Hardware, mounting brackets, adapters and plates shall be provided as required for magnetic contact switch installation.
         1) Manufacturer Nascom, Part No. N1178Cx/STDD, or approved equal
            a) x = denotes color, (W) white, (T) tan, (G) gray and (B) brown.
   3. Surface Mount
      a. Door contact shall be a hermetically sealed reed switch nominally 3"L x 1"H x 0.50"D with matching actuating magnet. Mounting holes shall be on 2-inch centers. Contact and magnets shall be in brushed anodized aluminum tube housing. Contact shall be sealed in our exclusive polyurethane potting compound. Right angle mounting bracket shall be included with contact.
         1) Manufacturer Interlogix, Part No. 2507AD-L
   4. Overhead Surface Mount
      a. Overhead door contacts shall be U.L. Listed heavy-duty SPDT (Single-pole-double-throw) surface mounted magnetic contacts with 3-inch minimum gap size.
         1) Manufacturer Nascom, or approved equal:
            a) Channel mount, Part No. N505AUTMC/STSD

5. Specialty Magnets:
    a. Where door contacts are required at metal store front doors with top channel provide channel magnet, clip legs to accommodate shallow channel. Magnet shall be housed in flexible plastic housing with legs at each corner.
        1) Manufacturer George Risk Industries, Part No. MC-180, or approved equal

2.07 ELECTRONIC LOCKING HARDWARE

A. Electronic locking hardware shall be provided by Division 08.

2.08 GATE PEDESTAL AND HOUSING

A. Pedestal/ Stanchion:
    1. Stanchion shall be heavy duty, made of 4.0-inch square x .12-inch tube steel with a black UV protectant polyester powder coat. Stanchion shall be 44.65-inch tall with a 13.0-inch reach. The faceplate and baseplate shall be 8-inch square universal mount.
        a. Manufacturer Pedestal CEO, Part No. HD-100

B. Housing:
    1. Housing shall be made of .5-inch polymer composite material and be 3.0-inch deep. The hood portion shall be made from .25-inch material and be 3.5-inch deep. Housing shall be UV rated with stainless steel hinge.
        a. Manufacturer Pedestal CEO, Part No. LANDO-KY-20x14-E-BLK

2.09 OPEN CABLING SUPPORTS

A. Accessories and mounting hardware shall be provided for securing supports to structure for a complete and working installation of open cabling supports. Supports shall comply with TIA requirements for structured cabling systems and pathway supports. Follow manufacturer's recommendations for quantity of cables supported.

B. Hook & Loop Fasteners:
    1. Hook and loop fastener rolls shall be offered in 15 and 75-foot lengths and be 0.5-inch in width. Shear strength; for plenum rated product shall be 29 PSI and non-plenum rated product shall be 23 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
        a. Manufacturer Leviton or equal:
            1) Non-plenum 15' roll, Part No. 43115-15
            2) Non-plenum 75' roll, Part No. 43115-75
            3) Plenum 15' roll, Part No. 43115-15P
            4) Plenum 75' roll, Part No. 43115-75P

C. Circular Cable Retainer:
    1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
        a. Manufacturer Erico Caddy, Part No. CAT CR50

D. J-Hooks:
    1. J-hooks shall have a Galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
        a. Manufacturer Erico Caddy:
            1) 1-inch Dia., Part No. CAT16HP
            2) 1-5/16-inch Dia., Part No. CAT21HP

2.10 CABLING

A. Cabling shall be sized to provide minimum resistance and minimum voltage drop to the devices being supplied. Voltages delivered to all devices shall be within the tolerance specified by the device manufacturer.
   1. Cabling shall be a minimum 18 AWG solid copper conductors for power connectivity.
   2. Twisted pair cable shall be used to prevent EMI/RFI interference with the proper operation of the circuits.

B. Cable shall be NFPA 262, CMP (plenum) rated unless otherwise noted.
   1. Cables installed in underground applications shall be rated for wet environments.

C. Cables shall adhere to the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
   1. Wiring shall be appropriately color-coded with permanent wire markers.
   2. Cabling shall have stranded copper conductors.
      a. Card readers: 18 AWG-6C with overall shield.
      b. RS-485: 24 AWG one twisted pair with overall shield
      c. Door position switch: 22 AWG-2C
      d. Lockdown buttons, keyed switch: 18 AWG-4C
      e. Request to exit: 18 AWG-4C
      f. Electrified lock/ exit device: 16 AWG-6C
         1) Refer to manufacturer requirements.
      g. Electrified mag lock/ hold open: 16 AWG-2C
      h. Sounder/ strobes w/tamper switch: 18 AWG-4C

D. Coordinate additional cabling requirements, other than those listed herein, for devices within the access control system shop drawings.

2.11 TERMINAL BLOCKS

A. Terminal blocks shall be screw connection, two connections with 1 position, 24 – 12 AWG and mount on DIN rails.
   1. Manufacturer Schneider Electric, Altech or equal

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide all labor, tools, supplies, software, hardware, materials, and equipment required for the design, installation, configuration/ programming and testing of a complete and operational system.

B. Install all equipment in accordance with manufacturer's instructions, approved Shop Drawings and as indicated on the Contract Documents.

C. Cabling shall be installed in conduit at non accessible locations, cable tray or open cabling supports in accessible ceiling spaces.

D. Where subject to mechanical damage, wiring shall be enclosed in metallic conduit and/ or surface metallic raceway.

E. Cabling shall not be enclosed in conduit or raceways containing AC power.

F. All devices shall be securely mounted. Provide necessary backing in walls or ceilings.

G. Properly ground the system per NEC requirements to the building safety grounding system to prevent electrostatic charges and other transient electrical surges from damaging the control panel.

H. Door hardware power supplies, by others, shall be located near doors with electronic door hardware where there are accessible ceiling spaces.

I. Provide connections to lockdown button(s), where indicated on the Contract Documents. Lockdown button shall provide manual override to lock or unlock electronic controlled doors.

J. Auto operator motor (ADA button): provide relays and cabling for card reader operation with ADA operators. Coordinate requirements with the electrical and door hardware contractors.

K. Elevator landing control: provide terminal strips and cabling for card reader operation with call buttons/ elevator cab. Coordinate requirements with the elevator contractor.
   1. A j-box shall have hinged cover sized appropriately for elevator cabling to terminate on terminal blocks next to the access control panel. Provide terminal blocks for cabling from the access control panel and separate terminal blocks for cabling to the elevator control panel with connections between the two terminal blocks to create a “demarc”. Label cover of j-box with “ELEVATOR CONTROL DEMARC”. Inside cover shall be labeled to identify which terminal blocks are associated with the landing/ floor.
   2. Each landing/ floor shall have a dedicated connection to the terminal strip and shall operate independently of other landings/ floors.

L. Keyed switches: provide cabling and connections to the access control panel. Keyed switches shall not bypass the access control panel or interrupt the power to the door hardware.

3.02 LABELING

A. General:
   1. Labels shall be permanent typewritten labels produced by a labeling machine.
   2. Labels shall be installed on cabling at each end with wrap around labels. Ensure labels are securely fastened.
   3. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
   4. Font type shall be Arial.
   5. Labeling shall be completed prior to the substantial completion date of the project.

B. Panel Labeling:
   1. Panel ID labeling shall be placed on the front cover of the enclosure.
      a. The labeling shall be as follows:
         1) 101-ACP.1 where:
         2) 101 = MDF/IDF Room (as indicated on the Contract Drawings)
         3) –ACP.1 = Panel name and number
   2. Circuit ID label shall be on the front of the enclosures. Labeling shall contain the electrical panel and circuit number connected to the panel and power supply.

C. Battery Labeling:
   1. Labeling shall be placed on the side of the battery viewable when opening the front cover of the panel.
   2. The labeling shall be as follows:
      a. 101-B.1-July 2023 where:
      b. 101 = MDF/IDF Room (as indicated on the Contract Drawings)
      c. B.1 = Battery ID no. (per room)

d. July 2023 = Month and year of installation

3.03 OPEN CABLING SUPPORT INSTALLATION

A. All cabling shall be run exposed as “open cabling” in ceiling spaces and ceiling plenums, unless otherwise noted.

B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.

C. Cabling supports shall be spaced no further than 4’-0” apart.

D. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.

E. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.

F. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.

G. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.

H. Follow manufacturer’s recommendations for quantity of cables supported in J-hooks and adjustable cable supports.

3.04 PROGRAMMING

A. Programming of the system shall include, but not limited to:

1. Programming user/ groups, door groups, creating maps, door schedules, access cards and/or e-mail notifications as defined by the Owner.
2. The system shall be programmed with “normal” opening and closing periods for each day of the week and thus suppressing the scheduled opening/ closing reports. The system shall only report on opening/ closings outside the pre-defined schedule.
3. If a credential is presented to a reader during a time or date that is not within its programmed privileges, the door shall not be unlocked.
4. If a lost/stolen credential is presented to the reader, access shall be denied, an alarm shall be transmitted to the local control panel.
5. Forced entry detection shall be enabled at doors equipped with an internal request to exit (REX). A forced entry shall be generated immediately whenever the door is opened without authorization. Authorization shall be determined by card, REX transaction at the door, or by command from the host system as described. Doors without an internal REX device shall not report forced entry.
6. Door held open detection shall be enabled at electronic controlled doors. A door held open event shall be generated immediately when the door is held open longer than 5 seconds.
7. The system shall automatically re-lock the electronic controlled portal when the door is sensed as closed and/or whenever the 2 second door relay unlock time expires.
8. Auto operator motor (ADA button) shall be disabled when the door hardware is in a locked state from the outside without an authorized credential read. Interior ADA button shall always be enabled to operate and unlock the door hardware if the door is in a locked state. When an authorized credential is presented to the exterior card reader the access control panel/ relay shall unlock the door enable the auto operator button allowing the motor to open the door.

9. Keyed switches shall change the door hardware to a locked/ unlocked state via the access control panel. If the door hardware's state has been changed via the keyed switch, and a lockdown occurs the access control system shall change the door hardware's state to be locked, or maintain the door hardware in a locked state.
10. Provide a safety mechanism called 'First Person In' to prevent assigned doors programmed for auto unlock from unlocking at the start of a designated time zone until a valid credential is first presented by an authorized cardholder.
11. Other programming requirements shall be coordinated with the Owner and shall be provided at no additional cost to Owner.

B. System Integration:
   1. Access Control and HMI Door Control Integration
      a. Provide an output from the PLC to the input on the WAC such that the access-controlled doors can be unlocked through a button on the touchscreen.

3.05 PRE-TESTING

A. After Work is completed, and prior to requesting the acceptance test, Contractor shall conduct a final inspection, and an operational pre-test of all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and operational pre-test.

B. Submit written notification to the Owner's Representative and the A/E that systems have been tested, are operating properly, and are ready for Acceptance at least 21 days prior to the requested test date.

3.06 FINAL ACCEPTANCE

A. Contractor shall submit a request for the Acceptance test in writing to the Owner no less than twenty-one days prior to the requested test date. The request for acceptance test shall constitute a certification from the Contractor that all Work is complete and in compliance with the Contract Documents; all systems have been tested; and that all corrections have been made.

B. Acceptance test shall be scheduled during a period when the building is unoccupied and a complete system test can be accomplished. Contractor shall provide the services of no fewer than two (2) technicians to perform the acceptance test. Technicians performing the acceptance test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the Work. Technicians shall be equipped with portable two-way radios that will be used during the test.

C. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance test.

D. During acceptance test, Contractor shall demonstrate all equipment and system features to the Owner. Contractor shall fully cooperate with the Owner and provide assistance with the inspection and test. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the Owner.

E. Any portions of the Work found to be deficient or not in compliance with the Contract Documents will be rejected. Owner will record any such deficiencies observed during the Acceptance test. A copy of said list will be provided to Contractor. Contractor shall promptly correct all deficiencies.

3.07 WARRANTY AND SERVICE

A. Contractor shall provide parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from Date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

B. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

3.08 TRAINING

A. Owner shall receive 4 hours of instruction in (2) 2-hour segments covering all aspects of operating the access control system.

B. Owner shall also receive assistance in configuring and inputting database to the Owner's satisfaction and until initial database is complete and functional.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Provide an electronic addressable intrusion detection system and other relevant components and accessories required to provide a complete operating system as specified herein.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 sections and Section 260500 apply to Work in this section.

1.02 RELATED SECTIONS

A. Related Sections
   1. 260500 – General Electrical Provisions
   2. 260510 – Basic Electrical Materials and Methods
   3. 260533 – Raceway Systems
   4. 260534 – Outlet Boxes
   5. 271100 – Telecommunications System
   6. 281300 – Access Control System

1.03 QUALITY ASSURANCE

A. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for security intrusion detection applications.

B. Codes and Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI C63.4 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
   2. Federal Communications Commission (FCC):
      a. Title 47 CFR – Part 15; Class B – Radiated and Conducted Emissions.
      b. Title 47 CFR – Part 68; rules governing the connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN).
   3. Underwriters Laboratories, Inc. (UL):
      a. UL 50 – Enclosures for Electrical Equipment.
      b. UL 60950-1 – Information Technology Equipment - Safety.
   4. Provide all wiring in accordance with Article 725 of the National Electrical Code and local ordinances, and other sections of these specifications.

C. Qualifications:
   1. Contractor shall be a certified reseller/ dealer, pre-qualified by the manufacturer for the purpose of offering the services as specified herein, at the time of bid.
   2. Contractors bidding security work shall have a minimum of five years of experience in the construction, testing, and servicing of systems of the type and magnitude specified herein.
   3. Contractor shall have completed at least five projects of equal or larger in size to this project within the past five years.
   4. Contractor shall have direct access to the tools and test equipment required to complete the work as defined herein.
   5. Contractor shall employ certified technicians skilled in the maintenance of the intrusion detection system and shall be located within 50 miles of the project site.

1.04 SUBMITTALS

A. Provide submittals in accordance with Division 01 and Section 260500.

B. Product Data:
   1. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.
   2. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
   3. Submit Product Data information sheets for coordination with item and model number.
   4. Where more than one product is shown on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
   5. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:
      a. Manufacturer’s certification to provide warranty
      b. Approved manufacturer classes satisfactorily completed

C. Acceptance Test Plan:
   1. An acceptance test plan form shall be prepared/ provided by the contractor.
   2. This form shall include separate sections for each device and a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

D. Shop Drawings:
   1. Drawings shall provide details of proposed system and the equipment and work to be provided. Drawings shall include point-to-point drawings of systems and wiring diagrams of individual devices including voltage drop calculations and other calculations as required.
   2. Connections to other equipment/ systems not specified herein.

E. Record Drawings:
   1. Keep complete set of security drawings in job-site office to show actual installation of cabling and equipment during construction.
   2. Use of this set of drawings for recording as-built conditions.
   3. Indicate where material, equipment, and system component are installed differently from that shown on the Drawings.
   4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner’s Representative for review and acceptance.
   5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
      a. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
   6. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.

F. Project Closeout:
   1. Submit closeout documentation to the Owner’s Representative and Architect under provisions of Division 01, Section 260500 and this section.
   2. Provide all project closeout documentation including but not limited to; test acceptance documentation, Record Drawings, manufacturer warranty and Operation and Maintenance Manuals.

1.05 SYSTEM REQUIREMENTS

A. Type of System:
   1. System shall be programmable locally and/or remotely.
   2. System shall consist of an integrated alarm processor, digital communicator, keypads, and shall support the connection, monitoring and reporting of intrusion detection devices.
   3. System shall include an automatic dialer to report alarms over dial-up telephone lines to the Owner's dispatch center.
   4. System shall connect to the County's existing system and report alarms to the dispatch center.
   5. Panic Buttons shall be provided to allow staff to trigger an alarm.
   6. Panic Buttons shall be identified by location to guide response.
   7. Door openings shall be monitored by door position switches.
   8. System shall communicate alarm conditions at both the individual point and at the area level.
   9. Upon actuation of any automatic detection device, breaking of any magnetic switch, or a keypad initiated alarm, all alarm functions shall operate in appropriate fashion.
   10. In the event of an alarm:
      a. Security alarms shall activate the remote signaling circuit of the security intrusion panel, which shall dial a coded alarm message to the remote monitoring station.
   11. Alarm reports shall be classified into sub-categories as follows:
      a. Opening and closing reports
      b. Service Log
      c. Test / Status Reports
      d. Diagnostic
      e. Relays
      f. Power / Phone Supervision
      g. Remote programming attempts

1.06 PRE-CONSTRUCTION MEETINGS

A. The subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.

B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Substations: The substitution of products shall adhere to the requirements defined in Section 017700 – Substitutions.
   1. Intrusion detection panels and equipment shall be from a manufacturer with at least 5 years of experience in the manufacturing of equipment.
      a. Approved manufacturers:
         1) Controllers / panels: Bosch, DMP, DSC
         2) Detection devices: Bosch**,** DMP, DSC

2.02 SYSTEM HARDWARE

A. The Security System shall be provided, based on the quantities and features required for the application.
   1. The control panel shall support the following:
      a. Integrated Conettix IP based communication providing high-speed, secure alarm transport and control.
      b. 32 programmable areas with perimeter and interior partitioning.
      c. 3 on-board hardwired points with expansion capability for a total of 599 using a combination of wired or wireless points.
         1) Point Expansion Modules shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
         2) Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.
      d. Local or remote programming, test, and diagnostic capability via a computer running the Remote Programming Software (RPS).
      e. System shall include an integrated USB port for local programming and diagnostics with no additional hardware modules required.
      f. System shall support the use of an Apple iOS device and/or Android device for control. Functions to include arming, disarming and control of outputs and access door. This application shall connect directly to the DACS using Ethernet, telephone or cellular communications and shall not require a third party server of network operations center (NOC).
      g. On-board Ethernet communications.
   2. Tamper switch shall be provided for each enclosure.
      a. Manufacturer Bosch:
         1) Panel kit, Part No. B9512G
         2) Enclosure, D8103
         3) Power Supply, Part No. D1640
         4) Lock & key, Part No. D101
         5) Tamper switch, Part No. D110

2.03 ACCESSORY INTERFACE MODULES

A. Auxiliary functions control interfaces such as activating bells, strobes, or lights shall be accomplished using the optional relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damages.

B. Functional criteria programmed into system memory shall be backed up by battery power. Additionally, the number of system programmers shall be severely restricted via the use of program locking features and passwords.

C. System Accessories and Modules, Manufacturer Bosch:
   1. SDI2 Interconnect Wiring Cables (Qty. of 10), Part No. B501-10
   2. Dual Class B, 2-wire initiating interface module shall have two separate powered loops for 12 or 24 VDC.
      a. Class “B” loop module, Part No. D125B
   3. Class A, 4-wire initiating interface module shall detect alarm in the presence of a single open or ground fault in the circuit. Each circuit shall have adjustable “alarm retard” and alarm reset delay.
      a. Class “A” loop module, Part No. D129

4. Auxiliary relay module shall allow switching of current or voltage. Relay module shall support 12 VDC or 24 VDC with two 5A at 30 VDC, dry contact outputs, “Form C”.
    a. Auxiliary Relay Module, Part No. D130
5. Relay modules shall be 2A at 30VDC, “Form C”.
    a. Single relay module, Part No. D133
    b. Dual relay module, Part No. D134
6. Octo-relay module shall provide 8 programmable 1A at 30 VDC, dry contact relay outputs, “Form C”.
    a. Octo-relay module, Part No. D8129
7. Octo-input module shall provide 8 programmable NO or NC inputs with 1kΩ EOL resistors for supervision.
    a. Octo-input module, Part No. B208
8. Octo-output module shall provide 8 programmable 1A at 5-24 VDC, dry contact relay outputs, “Form C”.
    a. Octo-output module, Part No. B308
9. Provide enclosures, lock & keys, tamper switches and mounting skirts/brackets as required to support additional accessory modules.
    a. Mounting Skirt (6-cards), Part No. D9002-5
    b. Flat mounting bracket, Part No. D137
    c. Right angle mounting bracket, Part No. D138
    d. Universal enclosure, Part No. B8103
    e. Lock & key kit, Part No. D101
    f. Tamper switch, Part No. D110

2.04 COMMUNICATION INTERFACE MODULES

A. Telephone Interface:
    1. Phone line shall interface with the phone lines for supervision of the telephone line connection to the Security System panel. When a telephone line is determined to be out of service by the system, the event will be annunciated locally on the keypad and transmitted to the central station. Transmission delay of this message shall be programmable from ten to two-hundred forty seconds. A telephone line switching modules shall be used to interface to a second telephone line.
        a. Manufacturer Bosch, Part No. B430

B. Ethernet Module:
    1. Ethernet module shall provide full two-way IP event reporting with remote control panel programming supporting 10/100 Base-T Ethernet communication for IPv6 and IPv4 networks. Ethernet module shall be NIST-FIPS197 Certified for 128-bit to 256-bit AES Encrypted Line Security.
        a. Manufacturer Bosch, Part No. B426

C. Cellular Interface:
    1. System shall use a cellular radio module as the primary, or backup, means of communicating to a receiver. Up to 4 IP Addresses shall be available for routing system events. Supervision time shall be programmable with a range of 5 to 65,535 seconds. Module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.
        a. Manufacturer Bosch, Part No. [see mfg for current model]
    2. Remote interface shall supports two-way IP communication over commercial cellular networks using a plug-in cellular communicator for compatible control panels.

a. Manufacturer Bosch, Part No. B450

2.05 POWER SUPPLIES AND BATTERIES

A. Primary Power Supplies:
   1. Step down transformer shall be a 16.5 VAC class two, plug-in transformer (included with system kit).
   2. Primary power supervision:
      a. When the primary power source fails, the system shall be configured to report an “AC Fail” message to a commercial central station. Transmission delay of this message shall be programmable from 5 seconds to 86 minutes with an optional 6 to 12 hour transmission delay. Message can also be programmed to “tag-along” with another message transmitted to the central station. System shall display a loss of primary power on the keypad.

B. Secondary Power Supplies (Standby Battery):
   1. Adequate battery power shall be provided as defined by the relevant application criteria, (UL 864 and 985 for alarm installations). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. Most current accepted version of NFPA 72 and any applicable local codes or AHJ requirements must be met accordingly.
   2. Secondary power supervision:
      a. When the secondary power source experiences an 85 percent depletion of its standby capacity, system shall be configured to report a “Low Battery” message to a commercial central station.

C. Power supplies and associated equipment shall be provided as required to support the system as specified herein and as indicated on the Contract Drawings.
   1. Manufacturer Bosch:
      a. Auxiliary power supply module, Part No. B520
      b. Dual battery harness w/long leads, Part No. D122L
      c. Sealed lead-acid battery, 12V, 18 Ah, Part No. D1218
      d. Transformer, 16.5 VAC, 40 VA, Part No. D1640
      e. UL – 1200mA 12 VDC battery charger module, Part No. D8132

2.06 DETECTION AND INTERFACE DEVICES

A. Intrusion System Keypad:
   1. Keypad shall have a color graphic touch screen with multi-line messaging. Keypad shall be white in color.
   2. Provide battery charging units were required to support additional keypads.
      a. Manufacturer Bosch, Part No. B942W
         1) Where keypad is located beyond 500’ from control panel, provide 5-line ATM style LCD display with up to 32 character keypad.
            a) ATM keypad, Part No. B920

B. Motion Detectors:
   1. Motion detectors shall be TriTech+ detector incorporating PIR signals with range adaptive Doppler radar into an intelligent algorithm to provide accurate and reliable alarm decisions. Detector shall support sensor data fusion technology that integrates the data from five different sensors to ensure alarm conditions are based on precise information and tri-focus optics technology that eliminates coverage gaps and false alarms. Detector shall support multi-point anti-mask with integrated spray detection to protect the detector against masking attempts.

2. Gimbal/ceiling-mount brackets shall be provided for all detectors, aim detectors away from exterior sources.
    a. Manufacturer Bosch:
        1) Adjustable standard range detector, Part No. ISC-PDL1-WA18G
        2) Long range detector, Part No. ISC-PDL1-WAC30G
        3) Gimbal-mount bracket, Part No. B328
        4) Ceiling-mount bracket, Part No. B338

C. Glass Break Detectors:
1. Glass break detector shall operate on a multiple frequency analysis response to distinct audio frequencies. Each detector shall provide the receiver, signal processing, alarm relay and operating power circuitry in the same enclosure. Detector shall provide a coverage range of 25-feet for glass sizes over 12-inch by 12-inch.
    a. Manufacturer Bosch:
        1) Ceiling mount, Part No. DS1108i
        2) Flush mount, Part No. DS1103i

D. Magnetic Door Position Switches:
1. Recessed
    a. Door contacts shall be UL listed 1-inch diameter magnetic door contact DPDT (double pole/ double throw) switch. Contact shall be self-locking for recessed mounting, closed loop, with 12-inch #22 AWG leads and 1-inch gap.
    b. Hardware, mounting brackets, adapters and plates shall be provided as required for magnetic contact switch installation.
        1) Manufacturer Nascom, Part No. N1178Cx/STDD, or approved equal
            a) x = denotes color, (W) white, (T) tan, (G) gray and (B) brown.
2. Surface Mount
    a. Door contact shall be a hermetically sealed reed switch nominally 3"L x 1"H x 0.50"D with matching actuating magnet. Mounting holes shall be on 2-inch centers. Contact and magnets shall be in brushed anodized aluminum tube housing. Contact shall be sealed in our exclusive polyurethane potting compound. Right angle mounting bracket shall be included with contact.
        1) Manufacturer Interlogix, Part No. 2507AD-L
3. Overhead Surface Mount
    a. Overhead door contacts shall be U.L. Listed heavy-duty SPDT (Single-pole-double-throw) surface mounted magnetic contacts with 3-inch minimum gap size.
        1) Manufacturer Nascom, or approved equal:
            a) Channel mount, Part No. N505AUTMC/STSD
4. Specialty Magnets
    a. Where door contacts are required at metal store front doors with top channel provide channel magnet, clip legs to accommodate shallow channel. Magnet shall be housed in flexible plastic housing with legs at each corner.
        1) Manufacturer George Risk Industries, Part No. MC-180, or approved equal
5. Panic Buttons
    a. Panic Button shall be U.L. Listed and allow surface or flush mounting of the cable. An option
        1) Manufacturer Bosch, or approved equal:
            a) Panic Button, Part No. ND 100 GLT

2.07 NOTIFICATION DEVICES

A. Horn:

1. Horn shall be a durable indoor/outdoor self-contained device. Horn shall consist of a single tone that delivers a warble sound output, 120dB output siren driver, and a dual action reed plunger for cover and rear protection. Housing shall be polycarbonate with a sturdy aluminum back plate to prevent warping and cracking. Horn strobe shall operate at 0.3A at 12VDC with a max current draw of 620 mA.
    a. Manufacturer Potter, Part No. SSX-52

B. Horn Strobe:

1. Horn strobe shall be a durable indoor/outdoor self-contained device. Horn shall consist of a single tone that delivers a warble sound output, 120dB output siren driver, and a dual action reed plunger for cover and rear protection. Strobe shall have an adjustable flash rate of 20 – 100 times per minute. Housing shall be polycarbonate with a sturdy aluminum back plate to prevent warping and cracking. Strobe shall use a colored mirror and lens to ensure that the color can be easily distinguished. Horn strobe shall operate at 0.3A at 12VDC with a max current draw of 748 mA.
    a. Manufacturer Potter:
        1) Horn strobe w/amber lens, Part No. SSX-52SA
        2) Horn strobe w/blue lens, Part No. SSX-52SB
        3) Horn strobe w/clear lens, Part No. SSX-52SC
        4) Horn strobe w/red lens, Part No. SSX-52SR

2.08 COOLER / FREEZER TEMPERATURE MONITORING

A. Environment monitoring console shall provide visibility of up to four environmental factors including high/ low temperature of -58° to 299°F (-50° to 150°C), humidity and water detection. Alarm outputs shall be four configurable Form C Relays (NO/NC) 1A @ 30 VDC.
    1. Manufacturer Winland Electronics:
        a. Console 24V, Part No. EA400-24V
        b. Temp sensors, Part No. TEMP-L-S
        c. Water surface sensor, Part No. W-S-S

2.09 OPEN CABLING SUPPORTS

A. Accessories and mounting hardware shall be provided for securing supports to structure for a complete and working installation of open cabling supports. Supports shall comply with TIA requirements for structured cabling systems and pathway supports. Follow manufacturer’s recommendations for quantity of cables supported.

B. Hook & Loop Fasteners:

1. Hook and loop fastener rolls shall be offered in 15 and 75-foot lengths and be 0.5-inch in width. Shear strength; for plenum rated product shall be 29 PSI and non-plenum rated product shall be 23 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
    a. Manufacturer Leviton or equal:
        1) Non-plenum 15’ roll, Part No. 43115-012
        2) Non-plenum 75’ roll, Part No. 43115-075
        3) Plenum 15’ roll, Part No. 43115-15P
        4) Plenum 75’ roll, Part No. 43115-75P

C. Circular Cable Retainer:
   1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
      a. Manufacturer Erico Caddy, Part No. CAT CR50

D. J-Hooks:
   1. J-hooks shall have a Galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
      a. Manufacturer Erico Caddy:
         1) 1-inch Dia., Part No. CAT16HP
         2) 1-5/16-inch Dia., Part No. CAT21HP

2.10 CABLING

A. Cabling shall be sized to provide minimum resistance and minimum voltage drop to the devices being supplied. Voltages delivered to all devices shall be within the tolerance specified by the device manufacturer.
   1. Cabling shall be a minimum 18 AWG solid copper conductors for power connectivity.
   2. Twisted pair cable shall be used to prevent EMI/RFI interference with the proper operation of the circuits.

B. Cable shall be NFPA 262, CMP (plenum) rated unless otherwise noted.
   1. Cables installed in underground applications shall be rated for wet environments.

C. Cables shall adhere to the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
   1. Wiring shall be appropriately color-coded with permanent wire markers.
   2. Cabling shall have stranded copper conductors.
      a. Door position switch: 22 AWG-2C
      b. Detectors: 18 AWG-4C
      c. Horn/ strobe w/tamper switch: 18 AWG-4C
      d. Keypads: 22 AWG-4C

D. Coordinate additional cabling requirements, other than those listed herein, for devices within the intrusion detection system shop drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide all labor, tools, supplies, software, hardware, materials, and equipment required for the design, installation, configuration/ programming and testing of a complete and operational system.

B. Install all equipment in accordance with manufacturer's instructions, approved Shop Drawings and as indicated on the Contract Documents.

C. Cabling shall be installed in conduit, cable tray or using open cabling methods when installed above accessible ceilings.

D. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.

E. Cabling shall not be enclosed in conduit or raceways containing AC power.

F. All devices shall be securely mounted. Provide necessary backing in walls or ceilings.

G. Properly ground the system per NEC requirements to the building safety grounding system to prevent electrostatic charges and other transient electrical surges from damaging the control panel.

H. Install detectors per manufacturer's installation instructions, with care to avoid windows, heat sources, potential sources of interference and/or other problem areas.

3.02 LABELING

A. General:
   1. Labels shall be permanent typewritten labels produced by a labeling machine.
   2. Labels shall be installed on cabling at each end with wrap around labels. Ensure labels are securely fastened.
   3. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
   4. Font type shall be Arial.
   5. Labeling shall be completed prior to the substantial completion date of the project.

B. Panel Labeling:
   1. Panel ID labeling shall be placed on the front cover of the enclosure.
      a. The labeling shall be as follows:
         1) 101-IDP.1 where:
         2) 101 = MDF/IDF Room (as indicated on the Contract Drawings)
         3) –IDP.1 = Panel name and number
   2. Circuit ID label shall be on the front of the enclosures. Labeling shall contain the electrical panel and circuit number connected to the panel and power supply.

C. Battery Labeling:
   1. Labeling shall be placed on the side of the battery viewable when opening the front cover of the panel.
   2. The labeling shall be as follows:
      a. 101-B.1-July 2023 where:
      b. 101 = MDF/IDF Room (as indicated on the Contract Drawings)
      c. B.1 = Battery ID no. (per room)
      d. July 2023 = Month and year of installation

3.03 OPEN CABLING SUPPORT INSTALLATION

A. All cabling shall be run exposed as "open cabling" in ceiling spaces and ceiling plenums, unless otherwise noted

B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.

C. Cabling supports shall be spaced no further than 4'-0" apart.

D. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.

E. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.

F. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.

G. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.

H. Follow manufacturer's recommendations for quantity of cables supported in J-hooks and adjustable cable supports.

3.04 PROGRAMMING

A. Provide a supervised signal to notify the Owner's monitoring agency. Contact the Owner's monitoring agency and confirm monitoring requirements. Provide connections and interface equipment and programming as required. Coordinate installation of dialer equipment.

B. Programming of the system shall include, but not limited to:
   1. Programming system configuration parameters (hardware and software, area/circuit numbers, communication parameters).
   2. Programming delays for arming/ disarming at all entry and exit locations.
   3. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of areas/loops.
   4. Programming passcodes according to the authorities and functions defined by the owner.
   5. Other programming requirements shall be coordinated with the owner and shall be provided at no additional cost to owner.

C. The arming procedure shall be as follows:
   1. Entering the arming code on the keypad shall cause the system to be selectively armed.
   2. System shall give visual and audible indication if it is armed while a non-auto-shunted area is in trouble status. A low battery condition shall give an audible alarm upon arming.
   3. System shall dial the monitoring station number to give a closing system status report and shall give visual or audible indication of the monitoring station verification signal (ring back).
   4. After system has been successfully armed and ring back has been received, the exit delay period (user programmable up to 4 minutes) shall begin (if the delay has not been canceled by the operator), allowing the operator to exit the building without causing an alarm.
   5. Entering an "area" disarming code on the keypad shall disarm that specific area only, other areas shall remain armed.

3.05 PRE-TESTING

A. After Work is completed, and prior to requesting the acceptance test, Contractor shall conduct a final inspection, and an operational pre-test of all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and operational pre-test.

B. The contractor shall test each device/ zone with the Owner's monitoring agency to verify proper reporting of devices/ zones.

C. The contractor shall submit a system printout of all components tested and certify 100 percent operation indicating all devices have passed the test criteria set forth by the manufacturer.

D. Submit written notification to the Owner's Representative and the A/E that systems have been tested, are operating properly, and are ready for Acceptance at least 21 days prior to the requested test date.

3.06 FINAL ACCEPTANCE

A. Contractor shall submit a request for the Acceptance test in writing to the Owner no less than twenty-one days prior to the requested test date. The request for acceptance test shall constitute a certification from the Contractor that all Work is complete and in compliance with the Contract Documents; all systems have been tested; and that all corrections have been made.

B. Acceptance test shall be scheduled during a period when the building is unoccupied and a complete system test can be accomplished. Contractor shall provide the services of no fewer than two (2) technicians to perform the acceptance test. Technicians performing the acceptance test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the Work. Technicians shall be equipped with portable two-way radios that will be used during the test.

C. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance test.

D. During acceptance test, Contractor shall demonstrate all equipment and system features to the Owner. Contractor shall fully cooperate with the Owner and provide assistance with the inspection and test. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the Owner.

E. Any portions of the Work found to be deficient or not in compliance with the Contract Documents will be rejected. Owner will record any such deficiencies observed during the Acceptance test. A copy of said list will be provided to Contractor. Contractor shall promptly correct all deficiencies.

3.07 WARRANTY AND SERVICE

A. Contractor shall provide parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from Date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

B. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment. Correct any system defect within twenty-four (24) hours of receipt of call from the Owner.

3.08 TRAINING

A. Owner shall receive 4 hours of instruction in (2) 2-hour segments covering all aspects of operating the intrusion detection/panic alarm system.

B. Owner shall also receive assistance in configuring and inputting database to the Owner's satisfaction and until initial database is complete and functional.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. This section is a Division 28 Security Electronics section, and is part of each Division 28 section.

B. Drawings and General Provisions of contract, including General and Supplemental Conditions, Division 01 Specification sections and all Division 28 sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Furnish and install new Security Video System components, and modify and integrate existing system components as indicated on the drawings, and as required for system performance in accordance with the project requirements set forth in the specifications.

1.03 OPERATION

A. System Operation: The Security Video System shall be controlled through the browser software interface with a mouse or through a touchscreen interface.

1.04 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of Security Video System components and accessories.

B. UL Compliance and Labeling: Provide Security Video System components which are UL-listed and labeled.

1.05 SUBMITTALS

A. Product Data - Submit manufacturer’s data for Security Video System components including, but not limited to, roughing- diagrams and instructions for installation, operation, and maintenance, suitable for inclusion in maintenance manuals. Also include riser and wiring diagrams, and cut sheets.

PART 2 PRODUCTS

2.01 IP CAMERA DOMES

A. Provide all new IP Cameras with all hardware and mounting accessories required for mounting as intended.

B. Type 180 IP Camera Dome shall be Hanwha Techwin PNM-9030V or approved equal.

C. Type 4K IP Camera Dome shall be Hanwha Techwin PNV-A9081R or approved equal.

D. Type 2 IP Camera Dome shall be Hanwha Techwin PND-A6081RV or approved equal.

E. Provide all mounting accessories as required for a complete and operational deployment.

F. Cameras shall utilize H.264 video compression for streaming and recording.

G. Category 6 cabling shall be provided from a Patch Panel in the MDF to each camera.

H. Patch into Owner Provided PoE Switch.

2.02 CERTIFICATIONS

A. UL

B. CE

C. FCC, Class A

2.03 WARRANTY

A. 3 years, parts and labor

2.04 APPROVED MANUFACTURERS

A. Approved Manufacturers of IP Cameras includes, Vicon, Bosch, Axis, and Avigilon.

PART 3 EXECUTION

3.01 INSTALLATION OF SECURITY VIDEO SYSTEM

A. Installation should be performed by qualified service personnel only in accordance with the National Electrical Code or applicable local codes.

B. Install Security Video System as indicated, in accordance with equipment manufacturer's written instructions.

C. Wiring and conduit arrangement shall be as shown on the drawings. Wire types shall be as recommended by the manufacturer.

D. Cameras shall be installed at locations indicated. Allow for relocation of devices up to 10 feet at the direction of the Owner or Architect/Engineer.

3.02 FIELD QUALITY CONTROL

A. Test all equipment and demonstrate the proper operation of the system to the Owner's representative.

3.03 WARRANTY

A. The products and installation shall be warranted for one year from date of final acceptance against defects in material and workmanship. Should the manufacturer's product warranties expire on a date earlier than one year following the date of Substantial Completion the contractor shall provide the balance of the warranty.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description: Design, furnish, install, and connect analog addressable, intelligent fire alarm and detection system required to form a complete coordinated system ready for operation. It shall include, but not be limited to, initiating devices, alarm notification appliances, control panels, annunciators, auxiliary control devices, power supplies, batteries, wiring and ancillary devices as shown on the Contract Drawings, as specified herein or as required to meet AHJ requirements. Contract Drawings and Specifications indicate minimum system requirements. This is a bidder-designed system and it is the responsibility of the fire alarm system vendor to provide an AHJ approved system and design.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Authorities Having Jurisdiction (AHJs):
   1. Chehalis Fire Department.
   2. Washington State Fire Marshall.

C. Codes and Standards:
   1. NFPA 70, National Electrical Code (NEC).
   2. NFPA 72, National Fire Alarm Code.
   3. UL 268, Standard for Smoke Detectors for Fire Alarm Signaling Systems.
   4. UL 864, Control Units and Accessories for Fire Alarm Systems.
   5. UL 217, Standard for Smoke Alarms.
   6. FM Global.

D. Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories. Components and systems UL listed and labeled for fire alarm systems and fire alarm and detection systems and accessories and FM approved. Comply with applicable State and local requirements.

E. Comply with applicable provisions of current NFPA 72, local building codes, and requirements of AHJs.

F. Permits and Fees:
   1. Arrange for inspections and pay for all required licenses, permits, inspections, plan review fees and any other fees.
   2. Submit complete set of fire alarm system submittals to AHJ for approval.

G. Fire Alarm and Detection System Installer Requirements:
   1. The installer shall be an authorized manufacturer’s agent staffed with factory-trained and certified sales and service technicians. The installer shall have been the designated manufacturer’s representative in the local market for a minimum of five (5) years.
   2. The local office of the installer shall be UL listed under the UUJS or UUFX category as a qualified fire alarm system provider.
   3. The fire alarm system installer shall coordinate the installation of the fire alarm system including the preparation of shop drawings and submittals to the Authority Having Jurisdiction.

4. System design and preparation of shop drawings shall be by factory-trained personnel with the following qualifications: NICET-certified fire-alarm technician, Level II minimum.
5. System installation shall be by factory-trained personnel with the following qualifications: NICET certified fire alarm technician, Level II minimum.
6. System commissioning and testing shall be by factory-trained personnel with the following qualifications: NICET certified fire alarm technician, Level II minimum.
7. Contractor's factory trained technical representative shall respond to job site within 24 hour period for emergencies relating to system.
8. Emergency response is defined as having a technician actively troubleshoot and correct problem at job site.

H. Existing Systems: Maintain system operation during construction or provide complete fire watch as required by the local AHJ. Provide protection for existing smoke detectors near construction activity resulting creation or agitation of dust or other debris that may interfere with smoke detector functionality.

1.03 SUBMITTALS

A. Comply with requirements in Division 01 and Section 260500.

B. Installer Qualifications.

C. Detailed description of equipment anchorage devices on which certification is based and their installation requirements. Sequence of Operation Matrix: Provide a sequence of operation matrix which includes all trouble, supervisory and alarm conditions monitored by the system. The matrix shall be included in the shop drawing set. Provide written sequence of operation that describes the interlocks between the Fire Alarm system and all other building systems (Fire suppression, HVAC, Access Control, etc.).

D. Product Data: Submit manufacturer's technical product data for fire alarm and detection systems components including, but not limited to, roughing-in diagrams and instructions for installation, operation, and maintenance, suitable for inclusion in the Maintenance and Operation Manuals. Include riser and wiring diagrams for panel and system components.

E. Shop Drawings: Indicate equipment and device locations and connecting wiring of entire fire alarm and detection system. Include layout wiring and riser diagrams, point-to-point diagrams, and floor plans with notification appliances, raceways and wiring routing, including device addresses and strobe candela ratings.

F. Details and schedules to include:
1. Battery Calculations.
2. Notification Appliance Circuit Calculations and Loads.
3. Strobe Circuit Voltage Drops.
4. Notification Appliance Circuit Schedules.
5. Symbol Legend and Wiring Code (per manufacturer's requirements).
6. I/O Point and Relay Schedules.
7. Typical Wiring Diagrams indicating connections between panel modules and field devices and auxiliary interfaces (i.e. elevator controls, fire doors, etc.).

G. Acceptance Test Procedure: Submit a written Acceptance Test Procedure (ATP), approved by the AHJ, to Engineer at least thirty days prior to scheduled testing. The ATP shall include step-by-step procedures for performance testing every fire alarm device and system output to demonstrate functionality in accordance with specification requirements.

H. Test Reports:
1. Field test reports.

2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

I. Obtain from each AHJ written certification that the permanent installation has been inspected and that it complies with AHJs' published regulations and requirements. Submit prior to Substantial Completion.

J. Operation and Maintenance Data: Comply with requirements in Section 260500. In addition, include the following:
   1. Prepare complete, simple, understandable, step-by-step, testing instructions with recommended and required testing frequency of equipment with methods for testing equipment. Include trouble-shooting manual.
   2. Prepare complete, easy-to-read, understandable maintenance instructions including the following information:
      a. Instruction on replacing components of system including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.
      b. List of equipment and components with address and phone number of both manufacturer and local supplier of each item.
   3. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   4. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   5. Record copy of site-specific software.
   6. Submit minimum one week prior to system training.

1.04 SYSTEM DESIGN CRITERIA

A. Design, furnish, and install complete operable fire alarm and detection systems in accordance with the latest adopted editions of IBC, IFC, NFPA 72, and applicable city, county, and state laws, codes, and standards.

B. Drawings reflect minimum Owner requirements. The Contractor's scope of work shall include but not limited to the following:
   1. Complete fire alarm system based on the available architectural, civil, structural, mechanical and electrical drawings.
   2. Wiring systems associated with fire alarm system.
   3. Provide additional smoke detectors, heat detectors, manual alarm stations, horns, visual notification appliances, speaker notification appliances, bells, door holder controls, fire shutter and fire curtain controls, panels, power supplies, and control graphic annunciators associated with fire alarm system.
   4. Provide auxiliary controls and switches including interposing control, monitor relays, and interconnection coordination for monitoring of fire sprinkler system tamper, flow and pressure switches, mechanical equipment shutdown and smoke and combination fire/smoke damper controls, elevator controls, smoke evacuation controls, area pressurization controls.
   5. Audibility and Intelligibility requirements shall meet NFPA 72 and contractor shall provide bypass for any devices near manual microphone stations as required to support audibility and eliminate any feedback on the system.

1.05 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Perform functional test of existing fire alarm systems to verify the existing sequence of operations and signal transmission/interface points. Verify all existing systems that are part of the sequence of operations are in working condition. Submit documentation to show all systems, including elevator recall, elevator pressurization fans, HVAC shutdown, door release and fire smoke dampers are all functional before demolishing the existing system. If any items are not functioning the owner will review and provide direction.

B. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it “NOT IN SERVICE” until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment “NOT IN SERVICE” until removed from the building.

C. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.06 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1.07 EXTRA MATERIALS AND LABOR

A. General: Furnish and install additional devices as specified herein. For each device, include rough-in and fifty feet of raceway and wiring extended from local fire alarm circuit. Location of devices as required by authority having jurisdiction or owner. Include shop drawing revisions and engineering time to update drawings for resubmittal to AHJ. Turn over any unused devices to the Owner and obtain signed receipt.

1. Smoke detectors: Quantity three.
2. Duct smoke detectors: Quantity two.
3. Heat detectors: Quantity one.
4. Manual pull stations: Quantity one.
5. Wall mounted strobes: Quantity two.
6. Ceiling mounted horn/strobes: Quantity two.
7. Ceiling mounted strobes: Quantity five.
8. Wall mounted horn/strobes: Quantity five.
9. Detection Loop in fire alarm control panel: Quantity one circuit.
10. Output control loop in panel: Quantity one circuits.
11. Spare capacity on each loop: 25%.
12. Monitor Modules: Quantity five.
13. Control Relays: Quantity five.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm and Detection System: Subject to compliance with requirements, Gamewll-FCI. No substitutions.

2.02 FIRE ALARM AND DETECTION SYSTEMS

A. General: Electrically operated, electrically supervised, fire alarm and detection system as described herein. Include control units, power supplies, alarm initiating and indicating devices, conduit, wire, fittings, and accessories required for a complete operating system.

B. Comply with requirements in Section 260533 for raceways, Section 260519 for conductors, Section 260534 for outlet boxes, and Section 260529 for supports. Minimum wire size No. 16 AWG for initiating circuits and No. 14 AWG for indicating circuits.

C. Open cabling methods may be utilized above accessible ceilings. All cabling in exposed areas, above inaccessible ceilings and in walls shall be installed in raceway.

D. Notification Appliance and Signaling Line Circuits: NFPA 72, Class B.

1. Install no more than 100 addressable devices on each signaling line circuit. Provide isolation modules on signaling line circuits: 1) on each floor where serving multiple floors, and 2) so no more than 50 addressable devices can be out of service due to a single wiring fault.
2. Signaling Circuitry: An open circuit in any speaker or strobe circuit shall not prevent the balance of the notification appliance circuits from operating. The control equipment shall supervise the speaker and strobe circuits to detect wiring faults.
3. Selective Signaling: The system shall be configured to allow selective signaling by alarm type as well as by zone, floor, building, or general alarm. It shall also be capable of providing alarm signal to all zones simultaneously.

2.03 SYSTEM TYPE

A. Low voltage, point identification fire management system. Fire alarm and detection system shall monitor intelligent (analog) and addressable (digital) devices, traditional initiating devices, point identify alarm location, and transmit signals to monitoring agency.

B. Fire alarm control panel shall allow for loading or editing special instructions and operating sequences. System capable of on-site programming to accommodate and facilitate expansion, building parameter changes, and changes as required by AHJs. Software operations stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.

2.04 SYSTEM OPERATION

A. Alarm displayed on an 80 character alphanumeric display and on remote printer. Top line of characters shall be point label and second line shall be device type identifier. System alarm red LED shall flash on control panel and remote annunciator shall indicate specific device in alarm. Subsequent alarm received from another zone after being acknowledged shall flash system alarm LED on control panel and remote annunciator. LCD display and printer shall show new alarm information. Alarm tone shall occur within control panel and remote annunciator until acknowledged.

B. Alarm indicating devices silenced by entering locked control cabinet and operating alarm silence switch. Subsequent alarm condition shall reactivate signals.

C. Activation of any system smoke detector shall initiate an alarm. Alarm verification operation shall be programmed into the system for future use but not active until approved by AHJ.

Alarm verification function: control panel shall reset activated detector and wait for second alarm activation. If, within 1 minute after resetting, second alarm is reported from same or any other smoke detector, system shall process alarm as described previously. Time period for alarm verification reset programmable from 0 to 60 seconds. If no second alarm occurs within alarm verification time window, system shall resume normal operation. Alarm verification shall operate only on smoke detector alarms. Other activated initiating devices process immediately. Alarm verification operation selectable by device, not just by zone. Control panel with capability to display number of times zone or detector has gone into verification mode. Information displayed on control panel and transmitted to remote printer and remote annunciator.

D. Control panel shall have a dedicated supervisory and dedicated trouble condition indicator and acknowledge switch.
   1. Activation of any standpipe or sprinkler valve tamper switch shall activate system supervisory service audible signal and illuminate LED at control panel and remote annunciator. Include differentiation between valve tamper activation and open circuits or ground fault trouble conditions.
   2. Activating acknowledge switch shall silence audible signal while supervisory service LED.
   3. Restoring valve to normal position shall cause supervisory service LED to extinguish thus indicating restoration to normal position.

E. Include manual evacuation switch at control panel to operate systems alarm indicating devices. Other control circuits not activated. True alarm processed as described previously.

F. Alarm, supervisory and trouble conditions displayed on control panel from alphanumeric display, at remote printer, and at remote annunciator. If more than one alarm, supervisory or trouble status is initiated, operator may scroll to display new alarms.

G. Control panel capable of supplying minimum 6 Amps at 24 VDC, filtered and regulated. Power supply expandable to total ampacity required by system. Initial system shall include a minimum of 25% spare capacity.

H. Functions of control panel field programmable.

I. Include connection to fire sprinkler system tamper switches, flow switches and high/low pressure alarm switches. Include connection to tamper switches in exterior vaults and post indicator valves as required.

J. Include elevator fire alarm control.

K. Include Deluge Control relay connected to the fire alarm system.

L. Include connection from duct smoke detector relay to fan starter control circuit. Fans shut down on local detection only. Provide interposing relays as required for HVAC shutdown. Coordinate requirements with mechanical contractor and equipment vendor. Include interface relay to control system.

M. Include connection to smoke dampers and combination fire/smoke dampers. Dampers close upon activation of smoke detectors in adjacent areas or adjacent duct detection. Include interface relay.

N. Include fire alarm system power and fire closure signal connection to fire shutters and fire curtains. Shutters close on local detection only. Coordinate requirements with shutter/curtain supplier. Include alarm release signals and coordinate requirements with door hardware supplier for the following:
   1. magnetic door holders

O. Include system output relay for alarm signaling to mechanical control system specified in Division 23.

P. Live announcements or prerecorded messages. Live messages must take precedence over prerecorded messages.

Q. Notification appliance network must consist of loudspeakers and visual notification devices located to provide intelligible instructions at all acoustically distinguishable spaces designated by designer to receive messages.

R. Interface with FACU to use voice modules, visual alarms, and loudspeakers of fire-alarm system.

S. Comply with speech intelligibility requirements of NFPA 72.

2.05 POWER REQUIREMENTS

A. Include 120 VAC power from dedicated circuit for each control panel.

B. Include 120 VAC power from dedicated circuit for NAC panels. Maximum of three NAC panels per circuit. Include 120 VAC power from dedicated circuit for fire/smoke dampers. Minimum of one circuit per floor.

C. Include sufficient battery capacity to operate entire system upon loss of primary 120 VAC power in normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at end of this period. System shall automatically transfer to standby batteries upon power failure. Battery charging and recharging operations shall be automatic.

D. Circuits requiring system operating power shall be 24 VDC. Include individual fuses at control panel.

2.06 EQUIPMENT

A. Fire Alarm Control Panel: Modular construction with solid state microprocessor based electronics with a minimum of 25 percent spare point capacity. Include minimum 80 character minimum alphanumeric display to indicate alarms, supervisory service conditions, and troubles.

B. Control panel shall include the following:
1. 80 character LCD display.
2. Minimum of 2 indicating appliance circuits.
3. Non-volatile EEPROM memory.
4. Multiple password levels.
5. RS232 port for programming and printer and video display unit input/output.
6. Logic Statements.
7. Time Controls.
8. Sequences.
9. Actions.
10. Reporting of all sensors and zones.
11. Sensitivity setting by sensor (within UL Limits).
12. Alarm verification by point or zone.
13. Enabling and disabling of any system device or function.
14. Ground fault detection on all system devices and inputs.
15. Normal and silent walk tests.
16. Cards, Components, Amplifiers etc. as required to support peripheral devices on the system.

C. Programming:
1. Programming accomplished using a standard IBM compatible computer, either desk or laptop.

2. Resident program stored in non-volatile EEPROM memory.
3. System with capability to store system program on a hard disk for future changes, upgrades, and replacement.
4. Software to allow user to reprogram system points, add system points, add or change point descriptions, and update data file. System output functions field programmable to allow custom operation.

D. Printer: Black and white laser printer to record trouble, supervisory and alarm signals and programmable changes.

2.07 PERIPHERAL DEVICES

A. Manual Stations: Red with raised white lettering. When station is operated, handle shall lock in protruding manner to facilitate quick visual identification of activated station. Station capable of being reset using a key. Stations which require only a screwdriver for operation not acceptable.

B. Manual Station Guards: Plastic guards with built-in independent local alarm. Stopper Two or approved. Provide on all manual pull stations unless otherwise noted.

C. Smoke Detectors:
1. General: UL 268 listed and documented compatible with control equipment to which it is connected. Photoelectric type, unless indicated otherwise, with a plug-in base and visual indication of detector actuation. Detectors intelligent, addressable and with capability of alarm verification, sensitivity adjustment by detector, and “maintenance alert” circuitry. Integral addressable module.
2. Duct Smoke Detectors: UL 268A listed.
   a. Capable of operating in air velocity range of 300 to 2,000 feet per minute.
   b. Detectors with approved duct housing for mounting exterior to duct. Weatherproof housing for exterior locations.
   c. Perforated sampling tubes extending across width of duct and end support.
   d. Integral filter system air flow monitor to indicate presence and direction of air flow through detector.
   e. Control modules and relay(s) required for equipment shutdown circuit and connection to control system. Coordinate interface with mechanical equipment and controls.
   f. Where duct smoke detector is installed above a ceiling, include remote indicator lamp and magnet activated test switch mounted on ceiling below unit. Label remote lamp and test switch. Furnish test magnet to Owner.
   g. Nameplate indicating corresponding mechanical equipment name and “supply air” or “return air”, as applicable.

D. Combination Carbon Monoxide/Smoke Detectors:
1. General: UL 2075 and UL 268 listed and documented compatible with control equipment to which it is connected. Photoelectric type, unless indicated otherwise, with a plug-in base and visual indication of detector actuation. Detectors intelligent, addressable and with capability of alarm verification, sensitivity adjustment by detector, and “maintenance alert” circuitry. Integral addressable module.

E. Heat Detectors: Addressable, analog thermal detectors. Rate of rise feature accomplished with electronic, dual thermistors. Include built-in test switch and LEDs to indicate alarm condition and polling. Thermal head shall plug-in to base. Heat detector rated for the environment in which it is to be installed (135° typical).

F. Heat Detectors, Weatherproof: Automatic resetting rate of rise type suitable for exterior installation. Include addressable module. Temperature rating as required by the installation, 135° F minimum. Fenwal horizontal Detect-A-Fire Series or approved equal.

G. Primary Notification Appliances: Provide flush mounted combination horn/strobe Audio/Visual signaling appliances where required. Specific audible and visual characteristics shall be as follows:
   1. Visual Signals Fire Alarm: Furnish and install xenon strobes, synchronized in accordance with NFPA 72 chapter 4 and rated to UL 1971 standards. Strobes shall have a fixed candela rating, as follows: provide 15 candela in corridors and other areas up to 20' x 20', 75 candela in areas up to 40' x 40', and 110 candela in areas up to 50' x 50'.
   2. Audible Signals: Provide audible signal appliances designed to produce a minimum sound output of 85 dbA at 10', or 15 dbA above ambient; whichever is greater.
   3. Power Supplies: The power supplies provided for the system shall be capable of powering all notification devices simultaneously with a minimum of 20% spare capacity. Provide power supplies in increments of 8 Amps. Supervision of power supplies shall be integral to the panel. The need for separate monitor modules to supervise power supplies are not acceptable.
   4. Amplifiers: The amplifiers provided for the system shall be 24 Volt 40 watt max output. Amplifiers shall be integral to the panel or in a separate enclosure next to the FACP.

H. Multiple strobes visible in a single room coordinated to flash simultaneously.

I. Water Flow Switches: Provided by Division 21 and wired by Divisions 26, 27, and 28. Coordinate requirements. Sprinkler Valve Tamper Switches: Provided by Division 21 and wired by Divisions 26, 27, and 28. Coordinate requirements.

J. Provide Remote LCD Annunciators. The Fire Department remote annunciator shall have a LCD readout and adjacent building map to direct fire fighters to source of alarm. Wording on map shall reflect information on digital readout. Communication between the main fire alarm control panel and the remote annunciators shall be via an RS232 link. A graphic map shall be provided adjacent to the remote LCD annunciator.

K. Provide Graphic map. The Graphic map is a floor plan representation of the facility with a full color image printed on the reverse side of 10 mil. Polycarbonate Lexan. The printed image shall be laminated to a 1/8" rigid backing with a removable adhesive for future replacement. The graphic map shall be secured in a black (standard) anodized aluminum frame and mounted with a concealed security hanging system to prevent any unauthorized removal. Obtain approval of graphic map from AHJ. Graphic map shall include the following:
   1. Clearly legible room names and numbers for all floors of the building.
   2. Location of the Annunciator indicated with "You are Here" notation.
   3. Location of the Fire Alarm Panel.
   4. Location of Sprinkler Valve Riser Room (if available).
   5. Location of the Mechanical Room.
   6. Location of Electrical Room.
   7. Locations and zone numbers of Areas of Evacuation Assistance.

L. IP Communicator:
   1. Manufacturer: Notifier IPDACT-2UD, no substitutions.
   2. The IP Communicator shall be UL 864 listed for signaling under Other Transmission Technologies and comply with NFPA 72 requirements.
   3. The IP Communicator shall be capable of using low-cost, non-analog, digital telephone services such as cable or fiber optics.
   4. The IP Communicator shall not require change to the existing panel configuration. The IP Communicator must connect directly to the primary and secondary analog panel telephone ports.

5. The IP Communicator shall work over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
6. Data transmits over standard contact-ID protocol must be secured with the industry's highest level of encryption (AES 512 bit).
7. The IP Communicator shall support both dynamic (DHCP) or Public and Private Static IP addressing.
8. The IP Communicator shall support dual-destination IP receiver address for high redundancy configurations. All signals are sent to a secondary address should the primary become unavailable.
9. Provide user programmable UDP ports for flexibility and compatibility with firewalls and other network security components.
10. The IP Communicator shall be compatible with the following UL 864 Ninth Edition fire alarm panels: NFS-320, NFS2-640, and the NFS2-3030.
11. Provide installation, programming and testing in strict compliance with the manufacturer's direction.
12. Communicator shall send signals to the required monitoring agency.
13. Provide communicator programming hardware, software and services for contact ID reporting as requested by the Owner and AHJ.
14. Owner's selected alarm company shall be present during dialer programming.

M. Documentation Cabinet: Provide cabinet sized so that it can contain all necessary documentation. Cabinet shall be prominently labeled "System Record Documents".

PART 3 EXECUTION

3.01 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 FIRE ALARM AND DETECTION SYSTEM INSTALLATION

A. Install system in accordance with the Drawings and this section, applicable codes and manufacturer's recommendations. Install wiring in compliance with NEC for power and non-power limited fire protective signaling circuits. Upon completion, certify in writing to the Owner and general contractor that system has been installed in compliance with NEC.

B. Duct Smoke Detectors: Comply with IFC, NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

C. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

D. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

E. Mounting Heights:
   1. Manual Station: Operating handle approximately 48 inches above floor.
   2. Alarm Signal Devices: Approximately 80 inches above floor to centerline.
   3. Magnetic Door Holders: 78 inches to center line except as noted.

F. Wire:
   1. Per manufacturer's recommendations and as per NEC. Comply with requirements in Section 260519.
   2. Where required, provide wiring in metallic conduit. Comply with requirements in Section 260533.

G. Make conduit and wiring connections to equipment requiring monitoring or control. Including but not limited to sprinkler flow switches, sprinkler valve tamper switches, elevator controller, kitchen hood systems and appropriate air handling equipment.

H. Label junction boxes for fire alarm with minimum 1/4 inch letters: "FIRE ALARM".

I. Test conductors for ground conditions before making final wiring connections. Comply with requirements in Section 260526.

J. Maintain wiring color code throughout installation. Include color code identification in the Operation and Maintenance Manual.

K. Coordinate with appropriate subcontractors for installation of equipment and devices that pertain to other work in the contract.

L. Clean dirt and debris from inside and outside of the fire alarm equipment after completion of installation.

M. Coordinate installation of duct smoke detectors with Division 23 work.

N. Install remote annunciators as indicated on the Drawings and as required by AHJ.

O. Label all conductors in fire alarm panels, terminal blocks, and large pull boxes. Each conductor shall have a unique and specific designation.

P. All wiring shall be terminated/connected to a device, terminal block, or fire alarm panel. T-Tapping and splicing will not be permitted.

Q. Wiring installed in riser conduits shall have strain relief in j-boxes so that cable and connections are maintained and not damaged.

R. Document cabinet: Mount at the system control unit or an approved location on the protected premises. Provide printed label in document cabinet indicating owner project number.

3.05 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware". Connect hardware and devices to fire-alarm system.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated air-conditioning duct systems.

2. Alarm-initiating connection to elevator recall system and components.
3. Supervisory connections at valve supervisory switches.
4. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

C. Supervisory connections at elevator shunt trip breaker.

3.06 MANUFACTURER'S FIELD SERVICES

A. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

B. Include operations and maintenance instructions for the Owner's representative of devices including trouble shooting procedures.

3.07 FIELD QUALITY CONTROL

A. Check out of and final connections to fire alarm control panel by factory trained technicians in employ of factory authorized franchised dealer for products installed.

B. System, upon completion of installation, checked out, final connections made, and tested to initiating and indicating devices by factory trained technicians in employ of factory franchised dealer for products installed.

C. Test completed fire alarm and detection system in accordance with NFPA 72 in presence of the Owner's representative and the AHJ. Upon completion of successful test, certify in writing to the Owner and general contractor that system has been successfully tested and accepted by the AHJ. Include field test results in the Operation and Maintenance Manual.

3.08 TRAINING

A. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner. Provide hardware, software, and training to allow Owner to view and change panel programming on site and to view programming remotely.

B. A factory trained representative shall provide (1) 4-hour session to fully instruct the Owner's personnel as to correct operating testing, maintenance and troubleshooting procedures. Video tape this training session and provide copy to Owner for future reference. Schedule training with Owner in writing as least 7 working days in advance of the training date.

3.09 RECORD DRAWINGS

A. See Section 260500 for record drawing information. Accurately identify the final location, addresses and type of each device on drawings. Divisions 26, 27, and 28 Subcontractor shall keep a set of record drawings on site during construction and programming and shall mark-up changes made on these drawings. Transfer the mark-up information to an AutoCAD 2002-2014 format CAD file at the close of the project. Provide the Owner with the mark-up drawings, a CAD plot and CAD file on disk.

B. Provide a complete printout hard copy of the system program and an electronic backup copy or the site specific software for all future programming needs by authorized manufacturer/distributor per NFPA 72 4,5,2,3.(3).

END OF SECTION